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GREENING URBAN CENTRES : PROBLEMS OF PAST, PRESENT AND ITS PROSPECT

KALYAN CHAKRABARTI*

Introduction

West Bengal a mere 88 thousand square kilometres of areas, has nearly 55 million of population with the density of 615 per square kilometre with per capita forest area of 0.02 hectare. Actually 8% of the total population of India stand on 2% of its land space.

Besides the cool northern uplands, flat river-beds in the plains, swampy coastal regions, West Bengal has only 13.4% forests. The forests of West Bengal, however, as they exist today have territorially concentrated in three distinct regions only viz, northern montane and sub-montane tracts, the Gangetic delta and the lateritic south-western tract. They differ in composition from one another in every respect and the common measure among them is their near equality in area. In value and in terms of flora and fauna, they vary a good deal. The net area sown current follows, area not available for cultivation and uncultivated lands comprise 63.8%, 0.8%, 15.0% and 7% respectively.

The object of this study is to estimate the annual consumption of fuelwood in particular and to highlight the consumption of wood in various sectors of the State of West Bengal. It is also necessary to determine the extent of present and projected gap amongst the demand, supply and consumption pattern of wood and wood products. This will help the planners in formulating their plans on a sounder basis and would help evolve a realistic rationale to bridge the gap.

Material and Methods

Wood balance in the State of West Bengal shall be assessed from the wood production and wood consumption.

Production of wood shall be assessed from the published and unpublished records available from the study.

Consumption of wood is by households and by institutions including industries. The households consume wood for fuelwood, furniture, construction material, agricultural implements etc. Institutions consume wood as raw material, building material and fuelwood etc.

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(i) *Wood consumption by households* : Wood consumption by households shall be estimated by conducting a sample survey in rural areas as under :

(a) *Rural*—Stratified two stage sampling is proposed for the rural areas. Each district shall serve as stratum. Villages will be the first stage sampling units and the households as the second stage sampling units. List of villages are given district and police station-wise as per All India Census. About 2% of villages shall be selected at random from each stratum with probability proportion to the number of villages in each stratum.

Regarding selection of second stage sampling units i.e. households prior knowledge of the number of pucca and katcha households is necessary. A list of households is available village and gram panchayet wise and 5 households are selected at random with probability proportional to the number of katcha and pucca households in the sampled village. Then enumerators will fill up the questionnaire relevant for each household.

(b) *Urban*—The statistical design will be the same as for rural sector. Stratified two stage sampling is employed. Each district shall form a stratum. Five per cent of urban survey blocks shall be selected at random from each stratum with probability proportional to size and ten households shall be selected at random with probability proportional to the number of katcha and pucca households in each sampled urban survey block. The enumerators will fill up the questionnaire relevant for each household.

(ii) *Wood consumption by institutions* : Complete enumeration of all institutions falling in each sampled village (for rural sector) shall be made and the questionnaire shall be filled up in respect of each institution (same questionnarie is followed both in respect of household and institution). Institution will include all kinds of non residential units of wood consumption like Schools, Primary Health Centres, Panchayat Offices, Hospitals, any kind of industrial house, temples, mosques etc. In Calcutta and Howrah, only the principal will consuming institutions are kept within the purview of study because of enormity of the number of such institutions in this area. (Five different questionnaires have been formulated for the study which elicited relevant informations on wood balance).

Wood Balance information will be projected to a future date depending on demographic characteristics, supply and demand characteristics thereof.

Results and Discussion

The predominant role of wood and wood products to meet the bare needs of humanity is too well-known. National Forest Policy has thus very rightly emphasized to earmark 33% of total geographical area under forests. Actually the legally constituted forest area in India is barely 22% of the total geographical area and not all of which is the clad. Per capita forest area is thus barely 12 hectares. The position is further bleak in respect of West Bengal, where the forest area is barely 6.1%. On the other hand there is a marked rise in population trend of this State and with that demand of wood and wood products is also mounting to a signi-ficant extent. This marked trend in rise of demand of wood and wood products had been a cause of concern for the planners, Scientists and conservationists. A fresh

thought has also emerged in the matter of finding out suitable substitute for wood and wood products. This study will also help in estimating such alternative suitable substitutes of wood and wood products.

To meet this challenge of demand on wood and wood procucts, massive afforestation programme had already been launched in this State. But many questions remain unresolved even now. Whether there remains any gap between demand and supply of wood and wood products ? What are the measures to be taken to reduce such gap ? We also do not know of the magnitude and dimension of the present and projected gap amongst the demand, consumption and supply of wood and wood products. In order to get reasonable answers to these queries Forest Directorate, Govt. of West Bengal have embarked on a Statewide Wood Balance Study. This study was implemented as a time bound programme in sample villages (rural areas) and urban blocks (urban areas) in all districts of the State. There are 38,074 rural villages and 15,685 urban survey blocks. The study will facilitate in determining the present and projected demand, supply and consumption of wood and wood products in he State.

In West Bengal, fuelwood is a forest products of immense importance. Among the traditional renewable resources fuelwood is the most widely used, especially in rural areas (93.2%), of all the non-commercial energy consumed, the relative share in million tonnes of coal replacement, (m.t.c.r.) fuelwood provides 77.10% compared to 14.97% of agricultural wastes, 7.48% of dung-cake and 0.45% of biogas.

Moreover, fuelwood also dominants in the total energy consumption (non-comercial and commercial) according 41.97% followed by 40.06% of soft coke and coal briquette, 8.15% of agricultural wastes, 4.07% of dung-cake, 3.65% of Kerosene (for cooking only), 1.87% of LPG and 0.25% biogas.

Many factors influence fuelwood requirements, including population dynamics, climate, traditions and food habits, locale, income-level, availability and cost of substitutes. Consumption also varies according to urban and rural use. Rural consumption of fuelwood (93.2%) is higher than urban (6.8%) this is because of easier access to resources, greater domestic consumption for cooking and heating. Per capita consumption of different fuels is given.

Certain problems in utilisation of fuelwood aggravate the situation. The prevalent method of cooking rarely achieves fuel conversion efficiency of 10 to 12% as compared to various types of stoves that attain level of efficiency ranging from 30 to 50. The net result is high fuelwood consumption than is necessary, greater deforestation, longer collection distances and rising fuelwood prices.

Alternative sources of energy are beyond the reach of the rural poor, for whom fuelwood shortages represent the real energy crisis. The negative correlation between the income range and per capita consumption of woodfuel and expenditure is evident.

According to this study, the estimated total annual consumption of fuelwood is 16.85 million m^3 of which about 0.7 million m^3 is recorded outturn from forests. The consumption supply ratio (24 : 1) gives a

dismal picture compares to national picture where the similar ratio is 9 : 1. As to the reminder, it can only be said in general terms that it must come from the following sources : (i) unrecorded removals from forests, (ii) woodlands, such as those belonging to the non-forest areas outside the social forestry activities, (iii) Saw-mill offcuts.

Out of a total of 16 85 million m^3 the family sector constitutes 15.85 million m^3 (94.10%) followed by Institutional Sector 0.8 million m^3 (5.19%) and Cremation Sector 0.12 million m^3 (0.71%). The Institutional Sector covers hotels, restaurants, tea-stalls, sweet meat bhuji & oil fried shops, boarding, hostels, bakery, bricks, tiles and biri manufacturers. The study reveals that in rural areas, 65% of the total fuelwood consumption is by collection and 35% is through the trades, while in urban areas it represents 25% and 75% respectively. Overall position in the State is about 48% by collection and 52% by trade.

A substantial quantity of fuelwood consumed consists of twigs and branches collected by headloaders. The exact total number of headloaders in the State is not available. In the rural area, people resort to fuelwood collection not only for satisfying their own energy needs, but also for marketing a substantial quantity of fuelwood so collected with a view to earn their daily livelihood. Even women and children spend 3 to 6 hours a day for collection. Obviously, a considerable quantity of fuelwood under trade stated above is supplied by the rural poor. Thus headloading is a source of employment in the energy sector.

Annual per capita consumption of fuelwood in this State is 0.288 m^3. The pattern of per capita consumption differs between rural and urban areas. Per capita consumption (0.368 m^3) in rural areas is higher than that of urban areas (0.072 m^3). The highest consumption rate (1.103 m^3) seems to be in the mountainous region of Darjeeling district, while lowest consumption rate (0.017 m^3) is in Calcutta metropolis.

As the position of wood balance reflects on the total forest resource potential of the state, the wood consumption in urban centres largely depletes the balance in forest cover. This is primarily because of the fact that the supply potential of forest resource is too meagre in urban centres in comparison to rural areas and as such the urban elites have to depend largely on the supply inputs of forest resource on the rural areas largely. Calcutta city for example has a vast population density of more than 30,000 (thirty thousand) per square kilometre of the area and the fuelwood consumers in the city are naturally to depend on the supply of the forest resources of the rural areas as Calcutta does not have any significant source of ready supply of fuelwood. These problems had aggravated the wood balance position in the state and it is thus recommended that urban centres should utilise available land for afforestation. This will not only serve the needs of fuel energy but also may ameliorate the environment to its desired extent.

But urban centres do play another very important role. They play a vital role of demonstration in the socio-cultural activity of the people and the urbanites may motivate the large section of rural masses with their habits, custom and culture. It is thus expected that urban people will rise to the occasion to assess the gravity of the

problem of non-greening for correctly motivating the rural masses. Urban Centres however suffer from some inherent and in-built difficulties in the area of greening. Inadequate space, tremendous upward rise in human population and attendant problems, hard competition for livelihood and lack of any distinct leadership are the reasons which more often then not are pushing the urban greening attempts back to the wall. Industrial development and other ancillary human activities also pose deterrent problems to urban greening. But the limited natural resources available now would get further reduced for ultimate oblivion unless sincere attempts of greening are taken up right now, what is necessary is to make a proper and optimum greening plan for the urban centres. Infrastructural development is an area which need be properly developed for this august venture. There are Government and non-government organisations who are already engaged in the job. It is necessary to contact them and take a proper stock of their inputs to make urban greening a success. This is a project for the people, of the people and by the people and as such everybody should come forward in this venture to make it a success. There is no easier means to arrest the impending ecological disaster connected with deforestation and non-greening of the area.

A negative correlation had been established between monthly income and per capita woodfuel consumption on the one hand and between the monthly income and the percentage of expenditure on woodfuels on the other as will be evident from Table 1. An analysis of intersectoral woodfuel consumption in urban areas reveals that sectors like family, institution and cremation consume percentages about 65.68, 32.40 and 1.92 respectively as will be evident from Table 2.

Table 1

Income group-wise expenditures on fuels and annual per capita consumption of fuelwood (Family Sector) in Urban area

Monthly Income	Fuelwood consumed (m^3)	Percentage of expenditure on fuels
Below Rs. 250	0.133	12
Rs. 251- 500	0.074	12
Rs. 501-1000	0.044	9
Rs 1001-1500	0.033	8
Rs. 1501-2000	0.030	6
Above Rs. 2000	0 028	6

Table 2

Intersectoral woodfuel consumption in Urban areas

Sectors	Percentage of expenditure on fuels
Family	65.68
Institution	32.40
Cremation	1.92
	100.00%

Further, the critical review of the results of the wood balance study revealed that in urban sectors non-commercial fuel energy forms 12.38% while commercial fuel energy forms the balance 87.62%, soft coke, coal & briquette forming 71 70% of the total fuel energy consumption. Amongst the non-commercial energy firewood is consumed most being about 77% of the total

non-commercial energy. The survey also reveals the annual consumption of fuelwood on cremation both in rural and urban areas constitute about 18% of the total consumption of fuelwood on cremation in the state. This is evident from Table 4.

Table 3

Consumption of commercial and non-commercial forms of energy in West Bengal

Source	Urban		
	Original units	Million tonnes coal replacement (m)	Relative share of consumption in m.t.c.r. (%)
Non-commercial energy			
Firewood (million tonnes)	0.83	0.58	9.33
Agricultural wastes -do-	0 06	0.03	0.48
Dung-cake -do-	0.54	0.16	2.57
Biogas -do-	negligible	—	—
Total		0.77	12.38
Commercial energy			
Soft coke & Coal Briquette (million tonnes)	2.97	4.46	71.70
Kerosene (million KL)	0.10	0.61	9.81
L.P.G. (million tonnes)	0.04	0.38	6.11
Total : C.E.		5.45	87.62
Total		6.22	100%

Table 4

Annual consumption of fuelwood for Cremation

('000 m^3)

District	Rural	Urban	Total
Darjeeling	2.22	0.50	2.72
Jalpaiguri	5.44	0.60	6.04
Cooch Behar	4.28	0.19	4.47
Malda	3.40	0.15	3.55
W. Dinajpur	4.23	0.48	4.71
Nadia	5.44	1.13	6.57
Murshidabad	4.23	0.45	4.68
Bankura	6.69	0.29	6.98
Midnapore	18.45	0.93	19.38
Burdwan	8.75	2.35	11.08
Purulia	5.24	0.26	5.40
Birbhum	4.21	0.26	4.47
Hoogly	6.90	1.37	8.27
Howrah	4.08	1.94	6.02
24-Parganas	14.54	6.42	20.96
Calcutta	—	4.20	4.20
Total	97.98	21.52	119 50
Percentage :	82%	18%	100%

SUMMARY

The problems of greening any centre, region or state is intimately connected with the balance of supply, demand and consumption pattern of wood and wood products in the related area and the problem needs appraisal from the socio-economic context as well A wood balance study had been conducted in the State of West Bengal to determine the present and projected balance of wood and wood products both in rural and urban areas.

The paper is the outcome of a three-year comprehensive project (1983 to 1986) taken up in West Bengal under the guidance of the author in the name of wood balance study. The study was designed to determine the present and projected position of the supply, demand and consumption pattern of wood and wood products of the state so that the results may help the planners in formulating plans on a more solid foundation of facts. Stratified random sampling was employed for the entire State population and the results were derived from 18,758 respondents in both family and institutions falling at random in 752 sample villages and 696 urban census blocks drawn out of about 38,000 rural villages and 15,000 urban blocks. Some interesting facts of social ecology emerged from the study.

Against the recorded fuelwood production of 0.7 million m^3 in West Bengal, the estimated annual consumption is 16.85 million m^3 which means the consumption is about 24 times the supply. Amongst the traditional renewable resources fuelwood is the most widely used in rural areas (about 93.2%) of all the non-commercial energy consumed, the relative share in million tonnes of coal replacement (MTCR) fuelwood provides 77.1% compared to 14.97% of agricultural wastes, 7.48% of dung-cake and 0.45% of biogas. In the total energy consumption in this State including commercial and non-commercial energy fuelwood also constitutes about a significant 42% of the total consumption out of the total 16.85 million m^3 of fuelwood consumed annually, family, institutional and cremational sectors constitute 94.10%, 5.19% and 0.71% respectively. The study further reveals that in rural areas percentage of fuelwood collected and these, which are in trade, and 65% and 35% respectively while in urban areas, the picture is different. The respective percentages of collection and trade in urban areas are 25% and 75%. Annual average capita consumption is about 0.288 m^3 varying from 0.368 m^3 in rural areas to 0.072 m^3 in urban areas. The study also reveals that the proximity of forest area bears a positive co-relation to the per capita fuelwood consumption pattern, which is found to be the highest in Darjeeling district (1.10 m^3) and lowest in Calcutta (0.017 m^3). A negative correlation has been established between the monthly income of a family and the per capita consumption of fuelwood both in respect of urban and rural sectors. A negative correlation is also indicated by the study between the monthly income level and percentage of expenditure on fuel irrespective of urban or rural locations. The paper also reveals the sectoral distribution of woodfuel consumption and estimates the districtwise statistics of the State of West Bengal for the same to determine the extent of gap between supply and consumption wood-fuel over time and space.

नगर केन्द्रों को हरा बनाना – भूत और वर्तमान की समस्याएँ तथा इसकी संभावनाएं

कल्याण चक्रबर्ती

सारांश

किसी केन्द्र, प्रदेश या राज्य को हरा बनाने की समस्याएँ संबन्धित क्षेत्र में लकड़ी और लकड़ी से बनी वस्तुओं के प्रदाय और मांग के संतुलन तथा उपभोग की रूपसज्जा से गहरे जुड़ी हुई हैं तथा समस्या पर समाजार्थिक संदर्भ में भी विचार करने की आवश्यकता है। काष्ठ और काष्ठोत्पादों का वर्तमान और प्रक्षेपित संतुलन, ग्रामीय और शहरी दोनों क्षेत्रों में विनिश्चित करने के लिए यह काष्ठ संतुलन अध्ययन पश्चिम बंगाल राज्य में किया गया है।

यह अभिपत्र त्रिवर्शीय विस्तृत परियोजना (1983–86) का परिणाम है जिसे प्रस्तुत लेखक के निर्देशन में काष्ठ संतुलन अध्ययन के नाम से पश्चिम बंगाल में किया गया है। यह अध्ययन राज्य में काष्ठ और काष्ठोत्पादों का वर्तमान प्रदाय और मांग तथा उनकी उपभोग रूपसज्जा की वर्तमान और प्रक्षेपित स्थिति विनिश्चित करने के लिए किया गया ताकि इसके परिणामों से आयोजकों को तथ्यों के अधिक ठोस आधार पर योजनाएँ बनाने में सहायता मिल सके। राज्य की संपूर्ण जनसंख्या के लिए स्तरित यादृच्छिक न्यादर्शन विधि

उपयोग की गई और इसके परिणाम यादृच्छिक आधार पर लगभग 38,000 गांवों और 15,000 नगर खण्डों में से 752 नमूना ग्रामों और 696 नगर जनगणना खण्डो में पड़ने वाले परिवारो और संस्थानों से लिए गए 18,758 उत्तरदाताओं की जानकारी से तैयार किए गए। इस अध्ययन से सामाजिक परिस्थिति – विज्ञान के कुछ रोचक तथ्य सामने आए हैं।

पश्चिम बगाल के अभिलिखित उत्पादन 7 लाख घनमीटर के समक्ष अनुमानित वार्षिक उपभोग 168.5 लाख घनमीटर है जिसका अर्थ यह हुआ कि उपभोग प्रदाय से लगभग 24 गुना है। पारम्परिक नवीकरण – सभव संसाधनों में ग्रामीण क्षेत्रों में उपभुक्त सभी गैर–व्यापारिक ऊर्जाओ में ईंधनकाष्ठ सबसे अधिक (लगभग 93.2%) व्यवहार किया जाता है तथा लाख टन पत्थर कोयला प्रतिस्थापन में यह कृषि क्षेप्य के 14.97%, गोबर-उपलों के 7.48% और बायोगैस के 0 45% के मुकाबले में 77.1% ऊर्जा प्रदान करता है। व्यापारिक और गैर-व्यापारिक ऊर्जा को मिलाते हुए राज्य के कुल ऊर्जा उपभोग में ईंधनकाष्ठ का अंशदान कुल उपभोग का 42% है। प्रतिवर्ष उपभुक्त 168.5 लाख घनमीटर ईंधनकाष्ठ में परिवार, संस्थानों और श्मशान भूमि का भाग क्रमशः 94.10%, 5.19%, 0.71% है। इस अध्ययन से यह भी पता चला कि ग्रामीण क्षेत्रों में संग्रह किए गए ईंधनकाष्ठ और व्यापार में प्रयुक्त काष्ठ का प्रतिशत क्रमशः 65% और 35% है जब कि नगर क्षेत्रों में चित्र इससे भिन्न है। नगर क्षेत्रों में संग्रह और व्यापार का प्रतिशत 25% और 75% है। वार्षिक औसत प्रति व्यक्ति उपभोग लगभग 0.268 घनमीटर है जो ग्रामीण क्षेत्रों में 0.368 घनमीटर और नगर क्षेत्रों में 0.072 घनमीटर है। अध्ययन से यह भी पता चला कि वन क्षेत्र पास होने का ईंधनकाष्ठ के प्रति व्यक्ति उपयोग की सज्जा के साथ धनात्मक सहसम्बन्ध है और यह अधिकतम (1.10 घनमीटर) दार्जीलिंग जिले में तथा न्यूनतम (0.017 घनमीटर) कलकत्ता में पाया गया। परिवार की मासिक आय और ईंधनकाष्ठ के प्रति व्यक्ति उपभोग में नगर और ग्राम दोनों क्षेत्रों में ऋणात्मक सहसम्बन्ध पाया गया। अध्ययन द्वारा मासिक आय के स्तर और ईंधन पर किए जाने वाले खर्च का प्रतिशत इनमें भी नगर और ग्राम क्षेत्रों में स्थित होने से अप्रभावित ऋणात्मक सहसम्बन्ध देखा गया। यह अभिपत्र काष्ठईंधन उपभोग का क्षेत्रवार वितरण भी प्रकट करता है और काष्ठ-ईंधन के प्रदाय और उसके पउभोग के अन्तर की सीमाओं का विनिश्चियन करने के लिए पश्चिम बंगाल राज्य में उनके जिलेवार वितरण के आंकड़े समय और स्थान में उपस्थित करता है।

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BIOMASS ESTIMATION OF SOME OF THE TROPICAL PINES WITH SPECIAL REFERENCE TO *PINUS KESIYA*

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Introduction

Owing to the ever rising pressure of the population on the land, foresters are faced with the problem of catering the increased demand of raw material for wood based industries and for supplying the fuel and firewood requirement for the teeming millions living in the villages from the existing available forest land. In order to solve this problem various steps have been taken to augment the production. A large number of the exotic species have been introduced which are capable of better yield in short rotation compared to the indegenous species. Every State, therefore, is engaged in a very ambitious plan of the plantation activities under social forestry and afforestation programmes in the recent years. Even in the world, particularly in the tropics, there has been increasing emphasis on the plantation activities. More than 90% of the plantations of those existing at the end of 1980, were created after 1951 at a progressively increasing rate, although fast growing species like *Eucalyptus* and Poplars are being planted widely in India. Even then coniferous species, particularly pines are necessary to produce long fibres which are suitable for variety of pulp.

In India pines naturally occur in the Northern Himalayan ranges (*Pinus roxburghii* and *Pinus wallichiana*) and in eastern region (*Pinus kesiya*). The absence of pines in the tropical and sub-tropical zones has focussed the attention of pine in this region. A number of tropical pines have been tried at different sites in India. Although the search of finding most suitable species and provenance continues, but on the basis of the results obtained so far, few species suggest themselves as deserving attention by virtue of their superior growth, timber properties and adaptability. For instance, only two species are found suitable viz. *Pinus oocarpa* for altitudes about 1000 m in the plateau region area of Eastern Ghats and *Pinus caribaea* in the lower regions. The experience in Orissa on the basis of the trials, conducted between 700 to 950 m has been that *Pinus caribaea* is the most suitable species followed by *Pinus kesiya*. In Tamil Nadu *Pinus caribaea* appears to be the best, followed by *Pinus kesiya* in the altitudinal zone of 1050–1250 m, rainfall 1100-1200 mm. In the higher hills in the Palnis & Nilgiris *Pinus patula* has been most impressive. Only at Top Slip *Pinus radiata* grows fastest. Results in U. P. show that *Pinus patula*, *Pinus greggii*, *Pinus pseudostrobus* and *Pinus montezumae* when planted in deep moist soils at elevations between 1800 to 2000 m grow faster than local chir in early stages upto 15 years. *Pinus elliottii* and *Pinus taeda* come up on the skeleton soils between 1200 to 1500m, but survivals are poor. In

West Bengal *Pinus patula* has been found to be most suitable species for both upper and middle hills. Other species found to be promising included *Pinus kesiya* (Philippines origin), *Pinus greggii*, *Pinus taeda*, *Pinus caribaea* (var. *bahamensis* & var. *hondurensis*) and *Pinus elliottii*. Field trials at Amarkantak and Bastar in Madhya Pradesh tentatively indicated that *Pinus caribaea* var. *bahamensis* and *Pinus caribaea* var. *hondurensis* have been most successful. Sporadic attempts at the introduction of pine continued from time to time and since 1958 trials of exotic pines were started on a regular systematic manner in different parts of the country (Kaul *et al.*, 1982).

About 4000 ha of plantations of tropical pines has been raised. As per the report of the National Commission on Agriculture (1976), 20,000 ha of the plantations should be raised at the rate of 1000 ha per year. Productivity studies so far could be covered in respect of tropical pines for few selected localities in the country. Out of all the tropical pines, *Pinus patula* has been most widely planted and proved to be most promising.

Besides tropical exotic pines such as *Pinus* and *patula*, *Pinus elliotti*, studies of *Pinus roxburghii* and *Pinus kesiya* have also been completed. Studies of *Pinus patula* has been so far undertaken in Darjeeling, Nilgiris and Kodaikanal. *Pinus elliottii* has been studied in the demonstration area of F.R.I., Dehra Dun. Studies on *Pinus roxburghii* was also taken in the same locality. Recently productivity studies were completed in Koraput (Orissa). Results of studies of these species are briefly summarised. The study of biomass production in respect of *Pinus patula* carried out at Kodaikanal (George *et al.*, 1982), Darjeeling (Singh, 1982), Ootacamund (Malhotra *et al.*, 1985) is given in Table 1.

As regard the percentage contribution of different tree components to the aboveground biomass, the wood percentage increases from 35.8% (6 years) to 55 7% (10 years). The percentage contribution of bark, needle, twigs and branches decreases gradually with increasing age. The root biomass contribution decreases with increasing age 35.5% (6 years) to 23.8% (14 years)

Table 1

Biomass production tonnes/ha of comparable ages at Kodaikanal, Ootacamund and Darjeeling

Parameter	Kodaikanal				Ootacamund				Darjeeling			
Age (years)	6	8	9	12	6	8	10	12	6	8	10	12
Av. diameter (m)	—	—	—	—	7.7	15.4	21	21-6	—	8.6	15.9	16
Density (No./ha)	1000	980	980	—	1125	1000	856	922	—	900	1275	630
Above ground biomass t/ha)	70.6	117	1454	—	18.5	70.9	446	10.6	—	17.7	51.2	39 5

(Malhotra *et al.*, 1985) in Nilgiris.

Kaul *et al.*, 1982 have carried out the studies on distribution of organic matter in *Pinus elliottii* plantation in the demonstration area of Forest Research Institute, Dehaa Dun. The species was introduced on an experimental basis at Forest Research Institute, Dehra Dun in 1938, and thereafter small scale experimental plantations were raised in 1948, 1958 and 1968. The total biomass ranges from about 169 tonnes (10 years) to 529 tonnes (40 years) per ha with 81 to 85% being contributed by the above-ground parts and 19 to 15% by the roots.

As regards, the percentage contribution of different plant components to the above-ground biomass, the percentage contribution of wood biomass increases from 43.7 (10 years) to 65% (20 years) and thereafter fairly constant with increasing age. Similar trend is observed in case of twigs. This is, however, not the case with bark and needle where the percentage contribution of these components drop with the advancing age; the decrease is gradual in the case of bark (13.5% at 10 years to 8.4 at the age of 40 years). In the case of needle the drop is gradual after 20 years. The percentage contribution of branches varies with age; it does not show any definite trend.

Seth *et al.* (1963) have reported a total above-ground biomass of 68.5 tonnes/ha for *Pinus roxburghii* plantations (20 years) while Kaul *et al.* (1981) have observed that an above-ground biomass 145 tonnes/ha. The total biomass (above and below-ground) is of the order of 180.6 tonnes/ha, the roots constituting about 19.6% of the total biomass. With regard to the total contribution to the total above-ground biomass, the bole contribution is 73% followed by branches (13%), bark (8%), needle (4%) and twigs (2%).

Pinus kesiya has got a wide range of distribution particularly in South-east Asia (N.E. India, Thailand, Philippines). It grows best in areas of good rainfall and rather low temperature in winter. Higher regions of Eastern Ghats have been found to be quite suitable for its growth. Rainfall is usually 1000 & 2000 mm with a distinct dry season of 2-4 months, but in certain parts of India and Burma the rainfall is much more. Mean annual temperature varies from about 25°C at the higher elevations to about 25°C at the lowest. The extreme altitudinal range is from 300 to 3000 m, but optimum development is usually between 1000 and 1800 m. Height growth is rapid for the first 20 years then it slows down. Crowns are pyramidal or ovoid at first, becoming rounded or umbrella shaped with age. Crooked stumps are common in many stands in open conditions, branching becomes heavy and results in severe nodal swelling.

Pinus kesiya is a general purpose wood of moderate strength which has been found suitable for use as light and heavy structural timber, boat-building, flooring, furniture, cabinet work, turnery, pencils, plywood, oleo resin, though resin yield is lower than that of the other South-east Asian *P. merkusii* (Pousujja *et al.*, 1986).

It colonises sites degraded by fire or shifting cultivation. Large scale plantation of this species have been raised in parts of Africa, Asia & Latin America. It is reported that 75000 ha of this species in the Madagascar high lands alone (Mondeil, 1984). Observations have been that at

higher altitudes it grows compartively better than *Pinus patula* or *Pinus elliottii*. while in the low altitude it is inferior to *Pinus caribaea*. It has been widely planted in tropics and the estimated area of the plantation by the end of 1980 was 2,51,900 ha (Pande, 1983).

Recently biomass study was conducted in Koraput district of Orissa State, where for long time forests have been subjected to the practice of shifting cultivation and tropical pines have been found to be more effective in arresting erosion in comparison to other species. Study was conducted in plantations raised in Koraput Research Garden, which is situated at an altitude of 851 m. Mean annual rainfall is 1525 mm and maximum and minimum temperature varies from 38°C to 4.5°C. Soils are red coloured, neutral to acidic in reaction and have high iron content and low humus. The area is hilly and well drained. The results are given in Table 2.

The maximum contribution is made by the wood in the total above-ground biomass. It increases with age from 32% (4 years) to 68% (14 years). Total biomass and biomass of various tree components except needle has been found to be increasing Root, on an average is 22% of the total biomass except in 4 years old plantations, where root biomass is only 14% of the total biomass.

In general, the total standing biomass ranges from 6 3 tonnes/ha (4 years) to 9.7

Table 2

Standing biomass (kg/ha)

(Percentages are given in parenthesis)

Age (Yrs)	4	6	8	12	14
No. of tree/ha	700	2220	670	630	340
Wood	1715 (32%)	9812 (43%)	22894 (50%)	62861 (68%)	53258 (68%)
Bark	812 (15%)	2619 (12%)	4449 (10%)	8675 (10%)	8235 (10%)
Branch	763 (14%)	4151 (8%)	8784 (19%)	10527 (11%)	6848 9%)
Twig	784 (14%)	2087 (9%)	3095 (7%)	4712 (5%)	5437 (7%)
Needle	1379 (25%)	4102 (18%)	6218 (14%)	5859 (6%)	4829 (6%)
Total above-ground biomass	5453	22776	45[illegible]40	92634	78606
Root	896 (14%)	6749 (23%)	12062 (21%)	25735 (22%)	18224 (19%)
Total	6349	29525	27502	118369	96830

tonnes/ha (14 years), of which an average 80% is contributed by the above-ground biomass.

From the foregoing discussions it is clear that the tropical pines in the country have given the promise of large scale plantation. They are capable of solving the scarce supply of the raw material for forest based industries particularly paper and pulp. *Pinus kesiya* is a very useful species which can be used for variety of purposes. These species, if used as an alternative for some of the indegenous species, will greatly relieve the pressure on our limited forest areas.

SUMMARY

The paper summarises the studies conducted in respect of the tropical pines regarding biomass production. An attempt has been made to furnish the brief details about the biomass studies of *Pinus kesiya*, *Pinus patula*. *Pinus elliottii* and *Pinus roxburghii* in different localities in the country. The object has been to compare the total above-ground biomass and biomass of the different components of exotic pines with the indegenous pines. The results of these studies can be made use wherever these pines have given promising results to solve the demand of raw material for paper & pulp, fuel, and firewood requirement of the villages and they can also be put to other variety of uses to ease out the pressure on the indegenous species of our natural forests.

पाइनस केसिया के विशेष संदर्भ में कतिपय उष्णदेशीय चीड़ों में जैवपुंज बनने का अनुमानन

एम०सी० पाण्डे

सारांश

इस अभिपत्र में जैवपुंज उत्पादन के विषय में उष्णदेशीय चीडों पर किए गए अध्ययनों का सारांश दिया गया है। देश के विभिन्न भागों में हो रहे पाइनस केसिया, पाइनस पैट्ला, पाइनस इलियटिआई और पाइनस राक्सबर्घिआई के जैवपुंज अध्ययनों की बातें सक्षेप में देने का प्रयास किया गया है। लक्ष्य विदेशी चीड़ों और देशी चीड़ों के विभिन्न भागों के भूमि से ऊपर हुए जैवपुंजों की तुलना करना था। इन अध्ययनों के परिणामों को जहाँ भी ये चीड़ अच्छे परिणाम दे रहे हैं वहाँ लुगदी व कागज, और ईंधन के कच्चे माल की मांग का समाधान निकालने के लिए उपयोग किया जा सकता है तथा अन्यत्र प्राकृतिक वनों पर पड़ रहे दबाव को कम करने के लिए भी अनेक उपयोगों में काम लगाकर इन्हें उपयोग में लाया जा सकता है।

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GREVILLEA PTERIDIFOLIA (SYN. *GREVILLEA BANKSII*)—A SUCCESSFUL INTRODUCTION TO MINED OUT AREAS OF MADHYA PRADESH—I

Botanical Characteristics

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Introduction

State of Madhya Pradesh has got very rich deposits of many ores and minerals and as much as 1188 ha area is presently under different mining leases (Prasad 1986). State Forest Research Institute had taken up the reclamation and revegetation of various mined out areas of the State in 1979. The Institute has achieved success in evolving suitable technological package for reclamation of mined out areas of Bauxite, Coal, Dolomite, Limestone and Iron ores.

A number of exotics as well as indigenous species occurring prior to mining, in the natural forests have successfully been tried at these mined out sites. In bauxite mined out areas near Amarkantak (Shahdol district), nine species were tried for the first time in 1979, of which 7 species were found to be most successful. Two species of *Eucalyptus*, (*E. camaldulensis* and *E. tereticornis*), tropical pine (*Pinus caribaea*), *Acacia auriculaeformis* and two species of *Grevillea* viz., *G. robusta* (Silver Oak) and *G. pteridifolia*, a new introduction from Australia, have been found to be most promising (Prasad and Shukla, 1985; Prasad 1986; Prasad and Chadhar, 1987). The seeds of *G. pteridifolia* were supplied by the Commonwealth Bauxite Mining Company of Australia. This species has started regenerating naturally at an age of 3-4 yrs. Though natural regeneration of *Eucalyptus camaldulensis* and *Eucalyptus tereticornis* is generally not common but they have also started regenerating naturally at bauxite mined out areas at the age of about 6-7 years. Natural regeneration have not been observed in respect of other species even after about 9 years of planting. Though the results of the successful plantations at bauxite mined out sites have already been published elsewhere, (Prased and Shukla, 1985) yet the details of the new species have not been published so far. This paper, therefore, discusses the various botanical characteristics and production efficiency of *Grevillea pteridifolia* which is one of the most successful species on bauxite mined out areas.

Phenological characters of *Grevillea pteridifolia*

There is no record available about this species though it closely resembles *Grevillea banksii* which has been described with the help of illustrations by Dr. Alfred B. Graf in Exotica (Series 4, pp. 1969 .

Grevillea pteridifolia (Syn. *Grevillea banksii*) is a small tree attaining a height of 5-6 m. It's branches are hairy with alternate pinnate leaves having length upto 25 cm.

The segment is linear and white silky beneath. Flowers come up in one sided clusters, the colour being bright coral red. Flowering occurs in the months of December-January. Flowers appear in December end and they are in bloom till January.

The inflorescence is raceme. Anthers are yellow in colour, attached to corrola, epipetalous and bilobed. The gynoecium is bicarpellary with marginal placentation, perianth segments being recurved to outside. The fruit is oblique, coriaceous and dehiscing on one side. The fruit has one or two seeds.

Fruiting starts in the month of February and fruits ripen by April. If the fruits are not plucked in the month of April they split out and the seeds spread away. Fully viable seeds are obtained from the plants which are 3–4 years old.

One kilogram of seeds contain 25,000 to 30,000 seeds. Seeds can be stored (preferably in a cool place) upto 2-years without any appreciable loss of viability, however seeds stored upto one year give fairly high germination per cent (70–80%).

Nursery technique

The seeds collected in April are sown in the nursery bed in the month of October. Before sowing, seeds are soaked in plain water for 24 hours. The germination percentage is very high (70–80 per cent). Germination is completed in 25–30 days when two-leaved tiny plants, measuring about 2–3 cm appear in the bed. These plants are then pricked out and transplanted in the polythene bags (10 cm × 23 cm) filled with potting mixture of soil, sand and cow-dung manure (4 : 2 : 1). These plants are ready for planting in the month of June–July when they have 10–15 cm height and 7–8 leaves.

Planting technique

So far, State Forest Research Institute has tried *Grevillea pteridifolia* on bauxite and coal mined out dumps and on the site having yellow clayey soil. The planting technique in the case of bauxite mined out areas and coal-mine overburdens included digging of pits of 45 cm^3 size, filling these up with local soil (in the lower half of the pit) and mixture of humus rich sal (*Shorea robusta*) forest soil and 3 kg cow-dung manure, in the upper half of the pit. Polypotted plants which are 7–8 months old are planted in these pits in the month of July.

Growth pattern of the plants

Grevillea pteridifolia grows quite fast in the plantations. In the bauxite mined out areas it has proved to be one of the most promising species. Even at the nursery stage the growth rate is quite fast. From the Research Nursery Amarkantak 15 months old seedlings of *Grevillea pteridifolia* were taken randomly and the growth parameters of these plants were measured. The average growth data obtained are given in Table 2.

As far as the growth pattern of the plants in the plantation is concerned, during the first year of planting the collar thickness and root stock develops but the apical growth is rather slow. As a result of this, a 10–15 cm tall plant (at the time of planting) grows upto 25–30 cm only by January–February. However, after one year (July next) it picks up and by the end of two years the plant

Table 1

Growth parameters of Grevillea pteridifolia

(Year of plantation—1979)

Age (years)	Surv val per cent o plants	Average Height (cm)	Average G.B H. (cm)	M.A.I Height (cm)	M.A.I G B.H. (cm)
0	100	7	*	—	—
½	99	27	—	54	—
1½	98	162	—	103.3	—
2½	96	220	—	85.2	—
3½	96	419	—	117.7	—
4½	94	487	17.8	1(6.7	3.95
5½	94	501	—	89.8	Not measured
6½	94	571	19.8	86.8	3.05

* Diameter below 5 cm not recorded.

Table 2

Growth parameters of 15'months old Grevillea pteridifolia seedlings

Particulars	Attributes
Mean height in cms (average of 10 seedlings).	29.6
Mean collar girth in cms (average of 10 seedlings).	5.75
Mean shoot length in cms (average of 5 seedlings).	23.20
Mean root length in cms (average of 5 seedlings).	8.20
Mean of root-shoot ratio (average of 5 seedlings).	0.37

attains a height of 2.5-3.0 m. In the subsequent years also plants continue to grow at a faster rate. The MAI put on by the plants in the bauxite mined out areas is shown in Table 1.

Branching from stump is a rule rather than an exception. However, 5-6 years old plants when cut to observe it's coppicing power, they proved to be poor coppier as two years after the copping the coppice shoots could attain only 10-12 cm height.

An important feature of the strange adaptability of *Grevillea pteridifolia* to the bauxite mined out sites (poor site) is that it has started regenerating naturally over them. The regeneration was found in the plantations which are 3-4 years old. Regeneration was not only found within the plantation but outside the plantation also upto a distance of 30 metres, which shows that the seeds are capable of dehiscing and spreading to a distance of 20-30 m.

The feasibility of the success of planting of root-shoot cuttings of *Grevillea pteridifolia* has not so far been tried by this Institute. This year (1986-87) an experiment to test the performance of the root-shoot cuttings have been started. The results are, however, not very encouraging.

Being encouraged by the astonishing adaptability and fast growth of *Grevillea pteridifolia*, experiments to evolve the most suitable and economic technology for raising *Grevillea pteridifolia* plantation were carried out by this Institute. The results of some of the experiments have already been published (Prasad and Chadhar, 1987). *Grevillea pteridifolia* has been planted on the coal mined out areas also where it has performed equally well. The species *G pteridifolia* has, thus, been found to be an ideal species for the afforestation of most of the mined out sites.

SUMMARY

Large tracts of rich forests are being cleared for mining in Madhya Pradesh. After mining the areas are rendered wastelands where site conditions become inhospitable for normal plant growth. However, State Forest Research Institute, M.P., Jabalpur has got success in evolving methodologies for the rehabilitation and revegetation of such mined out sites. Out of the seven most successful species on the mined out areas of bauxite, an Australian species– ***Grevillea pteridifolia*** **has been found most promising. This species having adopted to the site has been found to be the best producer of organic matter. Natural regeneration of this species have also been observed. This species has been found successful at other mined out sites (coal and dolomite) also. Botanical characteristics of this species have been described in this paper.**

ग्रेविलिया टेरिडिफोलिया (पूर्व० ग्रेविलिया बैंकसिआई)—मध्य प्रदेश के खनिज निकाले क्षेत्रों में लगाने क लिए सफल वृक्ष जाति

रामप्रसाद व एस० के० चाधर

सारांश

मध्य प्रदेश में खनिज कार्य के लिए बहुमूल्य वनो के विस्तृत क्षेत्रों का निश्शेष पातन किया जा रहा है। खनिज निकालने के बाद ये क्षेत्र बंजर भूमि बन जाते हैं और स्थल दशाए सामान्य पादप वृद्धि के लिए अनुपयुक्त हो जाती हैं। तथापि, राज्य वन अनुसधान सस्थान, मध्य प्रदेश, जब्बलपुर खनिज निकाले ऐसे क्षेत्रों को पुन: सुधारने और वनस्पतियुक्त बनाने की रीतियाँ विकसित करने में सफल रही हैं बॉक्साइट निकाले खनिज रहित क्षेत्रों में लगाने के लिए सार्वाधिक सफल हुई सात वृक्ष जातियों में सबसे अच्छी आस्ट्रेलिया की ग्रेविलिया टेरिडिफोलिया पाई गई है। ऐसे स्थलों के लिए उपयुक्त बनी यह जाति सबसे अच्छी जैव पदार्थ उत्पादक पाई गई। इस जाति का प्राकृतिक पुनर्जनन होता भी देखा गया। यह वृक्ष जाति अन्य खनिज (पत्थर, कोयला और डोलोमाइट) निकाले क्षेत्रों में भी सफल रही। अभिपत्र मे इस वृक्षजाति की वानस्पतिक विशिष्टताएँ भी बताई गई हैं।

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INTRODUCTION OF EXOTICS IN SOUTH-WEST BENGAL—*ACACIA MANGIUM* IN COASTAL AREA (DIGHA-MIDNAPUR)

P.K. BASU*, D.K. GANGULY** AND G.S. MANDAL***

Introduction

In the coastal areas of South-west Bengal a very few species of trees of economic and other importance have been established successfully so far. The experimental plantation of the exotic species *Acacia mangium*, was created in the coastal area at Digha with the idea that the phyllodes of the plants being tougher (than usual leaves of broad leaved species) and thicker, would be able to withstand the gust of sea wind laden with sand and salt particles. Some seeds of the species collected from Australia were given by Ganguly. Few trees could be grown at Arabari of Midnapur. There are six numbers of healthy tree now standing in the nursery of Arabari Research Range at Sapadiha. These trees are being preserved as Seed trees. All other species of the Genus have been removed from nearby to prevent possible cross pollination. This species was also experimentally planted during 1985 in the lateritic tract of Midnapur (Kusumdahari of Arabari, Amlachati of Jhargram Research Range), Bankura (Unara of Beliatore Research Range, Hatirampur of Ranibundh Research Range) and also in the drought prone as well as lateritic area of Purulia (Pindra of Ajodhya Research Range) in alternate lines with *Acacia auriculaeformis* to assess its comparative performance. A brief note is given below regarding the nursery and planting technique practised at Digha.

Material and Methods

Digha, the coastal area of the Bay of Bengal was selected for the trial with a latitude of 21°37′ N and longitude of 87°32′ E respectively. The soil is purely sandy having a pH 5.75 Chemical and mechanical properties of soil of the mouza where the trees are standing have been analysed in the Silvicultural Research Laboratory (South), West Bengal, which is given in Table 3.

Acacia mangium, an exotic of Australia, starts blooming during the middle of August to late September. Colour of the inflorescence is white.

Seed matures during March and the seed weight found to 100 Nos. per gm approximately.

Pods were collected from trees, dried under the sun for a week then seeds collected. Seeds were collected from five years old trees in the Sapadiha Silvicultural nursery under Arabari Research Range for the trial.

Seeds were completely dried under

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the sun for one day. Then soaked in tapid water for 72 hours before sowing.

Polythene tubes of size 20 cm × 10 cm were filled up with sand, soil and cow-dung manure in the ratio 2 : 2 : 1. Seeds were sown in polypots during the end of April, 1985. Polypots were covered with thatch and light irrigation was given twice a day.

Germination was completed with in a month. Percentage of germination was 40.

Seedlings were kept in the nursery for about 3 months. Regular watering was done twice daily. Polypot soil was hoed up twice during the nursery stage. Powdered oil cake (mustard) was applied at the rate one table spoon per plant after two months of germination. Shade during day time was provided after germination and continued for a month. Then no shade was provided thereafter for hardening the seedlings.

Transplanting in the field was done during July, 1985 (29.7.85) after first shower.

Pit size was 45 cm × 45 cm × 45 cm and the spacing adopted, 5 m × 5 m. *Pinus caribaea* between two *Acacia mangium* plant was also planted for trial.

Watering was done through out the year excent during rainy season. Mulching was done twice, once in September and in October, 1985. Suphala 15 : 15 : 0 @ 70 gms per plant was applied during September, 1985 in single dose. Usual weeding and cleaning were done.

Regarding disease and pests nothing has been noticed so far.

Recently (July, 1986) we have been able to collect some fresh seed from the Forestry Research Centre of Malayasian Government for raising seedlings for our experimental trial. The Mysore Paper Mills Ltd. have also plantations of this species. Seeds of this species can be directly procured from the Senior Research Officer, Forest Research Centre, Sabah, Malayasia. The seeds are also available for supply with the Mysore Paper Mills Ltd., Old Mamcos Building, Kote Road, Shimoga-577 202, Karnataka.

Results and Discussion

Percentage of survival was 100 in the nursery and in the field.

So far (after one year of growth) it appears that it has established in the coastal land at Digha : at least it can be expected from the growth (Table 1). Photographs taken on 21.8.86 (less than one year age) are at Plates 1 and 2. The trees are full of branches growing from close to the ground having huge number of large foliage. So it will obviously be effective in soil conservation. Therefore, this species would be included in the small list of species suitable for coastal areas. Its performance in lateritic areas and in drought prone lateritic area is very encouraging so far. However, data are being collected regularly and results would be published in due course (one interim report is expected to be sent for publication during December, 1987). Artificial irrigation of course not being given elsewhere excepting at Digha where it is given to all other species during the first year.

Table 1

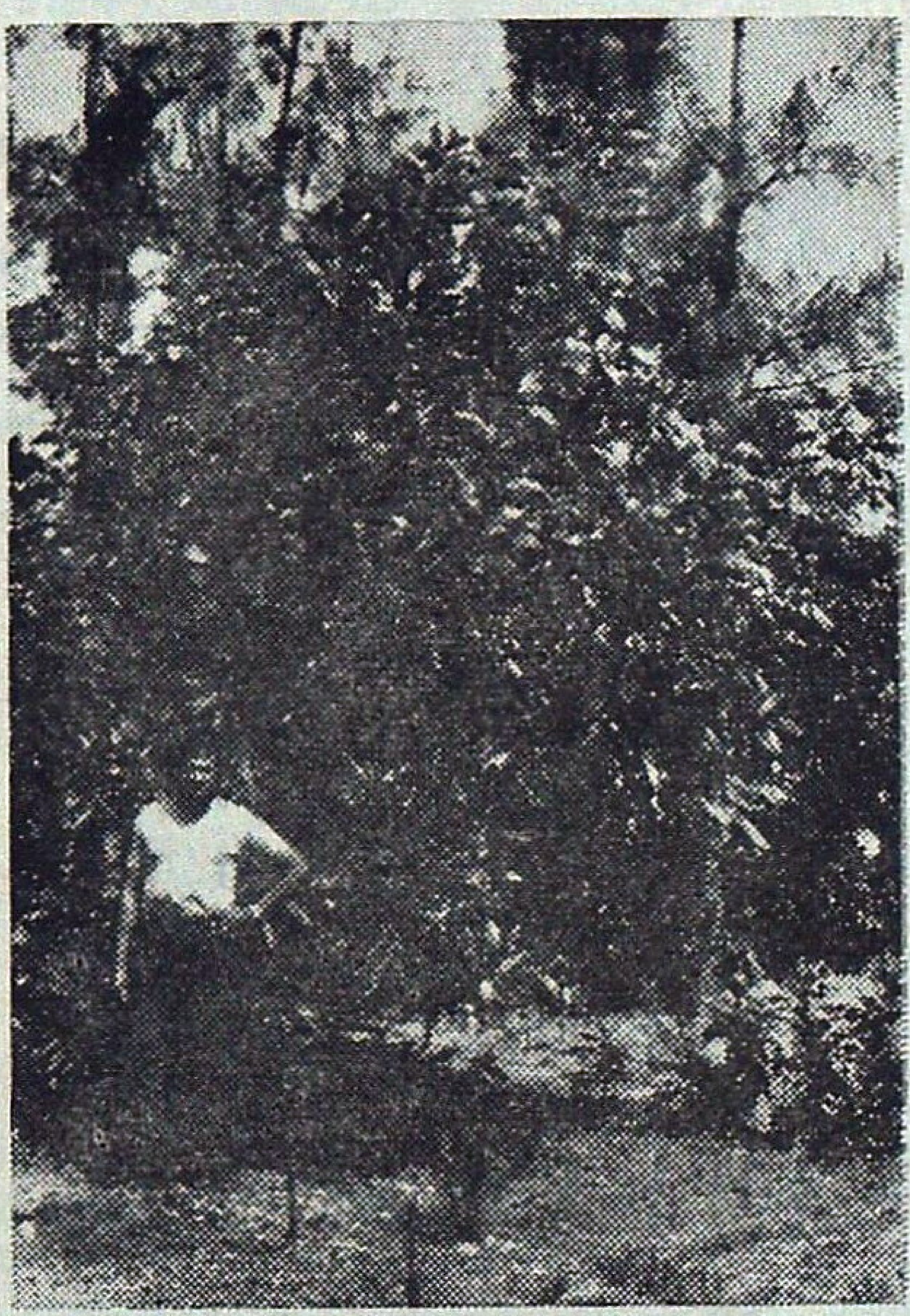
Growth data of Acacia mangium

Location : Digha Conservancy area (Gadadharpur Mouza)

Initial height measurement on 29.7.85 (cm)	Measurement after one year (29.7.86)		
	Height (cm)	Collar girth (cm)	B.H.G. (cm)
33	165	10	
28	110	5	
64	450	20	11
67	490	25	15
27	140	7	—
33	320	21	10
45	90	4	—
30	145	7	—
53	415	25	13
60	165	10	—
30	120	5	—
33	90	3	—
60	435	25	12
60	455	22	11
30	205	10	—
60	490	32	20
75	490	27	16
38	310	15	9
68	460	26	13
70	465	22	16
35	266	12	7
70	460	27	11
50	232	11	—
70	480	37	16
28	110	7	—
Total : 1217	7558	415	180
Avg. : 49	302	17	13
Max. : 75	490	37	20
Mini. : 27	90	3	7

Plate 1

Plate 2



Acacia mangium at Digha on 21-8-86; planted on 29-7-85.

Table 2

Growth data of A. mangium seed trees planted during July, 1980
(measured on 5.8.86)

Tree No.	BHG (m)	Height (m)	Standing volume (m^3) Approx.	Crown diameter (m)	Height of first main branch (m)	
1	0.53	14.50	0.3243	4.20	8.00	
2	0.54	11.00	0.2555	4.90	5.70	
3	0.32	9.60	0'0784	5.00	5.70	
4	0.53	12.50	0.5291	6.60	0.50	Trees No. 4, 5 and 6 have more than one trunk.
	0.46	12.00				
	0.25	9.50				
5	0.22	11.50	0.0806	2.00	0.40	
	0.20	11.40				
6	0.36	12.40	0.2488	5.00	0.30	
	0.35	12.40				

Table 3

Soil analysis report

Location	Depth of soil (cm)	U.S. Textural classification.	Mechanical composition			pH Value	Organic carbon	Available N (%)	Available P (%)	Available K (%)	C.E.C.
			Sand (%)	Silt (%)	Clay (%)						
Mouza : Sapadiha	0 – 30	Sandy clay loam.	50.7	28 6	20.7	4.85	0.1002	0.0081	0.0033	0 0210	5.685
J L. No. 17, Block : Keshpur	30 – 60	Clay loam.	42.5	23.9	33.6	4.70	0.0855	0.0069	0.0033	0.0205	8.440
Arabari.	60 – 90	Clay loam.	40.1	17.3	42.6	4.75	0.1800	0.0176	0.0012	0.0056	11.023

Measurements of the seed trees are given in Table 2. It is clear from the measurement that the trees have attained considerable height and volume within only five growing season.

Acknowledgement

Authors take the pleasure of expressing their sincere thanks to Shri S.K. Das, D.C.F., Ex-D.F.O., Working Plans Division, Midnapur for his valuable suggestions in course of inspection and to Shri P.K. Samanta, DR/Fr., who actually executed the experimental works as sincerely as it needed.

SUMMARY

A very few species have been successfully established artificially in the coastal areas. Considering the fact that the foliage of *Acacia mangium* are modified petioles (phyllodes) and would be tough enough to withstand the gust of the sea wind laden with sand and salt particles : it was experimentally tried in the coastal area of Digha during 1985. It has grown exceedingly well and expected to establish there. Other species are also being tried there. This species is also doing much better in producing biomass in comparison with its well known and established cousin the *Acacia auriculaeformis*, in lateritic tract of South-west Bengal, also in the chronically drought prone and lateritic area of Purulia district, result of which would be sent for publication in due course.

दक्षिणी-पश्चिम बंगाल में विदेशी वृक्ष जातियां लगाना—सागर तट प्रदेशों (दीघा मिदनापुर) में अकेसिया मैनजियम

पी०के० बसु, डी०के० गगूली व जी०एस० मंडल

सारांश

सागर तटीय क्षेत्रों में बहुत कम वृक्ष जातियां कृत्रिम रूप से लगाई जाने पर सफल हो पाई हैं। इस तथ्य को ध्यान में रखकर कि अकेसिया मैनजियम के पत्ते परिवर्तित पर्णवृन्त (पत्राभवृन्त) होते हैं और वे समुद्री हवाओं के रेत और लवण कणों से लदे झोंके सहने में काफी मजबूत रहेंगे, 1985 में दीघा सागर तट क्षेत्र में संपरीक्षण के तौर पर इसे लगाकर देखा गया। यह वहां बहुत ही अच्छी तरह बढ़ी और आशा है स्थापित भी हो जाएगी। अन्य वृक्ष जातियां भी लगाकर देखी जा रही हैं। यह वृक्ष जाति अन्य सुज्ञात और जमी-जमाई अपनी बन्धु जाति अकेसिया औरिकुलीफार्मिस के मुकाबले में जैवपुंज उत्पादन में भी दक्षिणी-पश्चिम बंगाल के इष्टकिजीय क्षेत्र में श्रेष्ठतर चल रही। पुरूलिया जिले के भारी सूखा पड़ने वाले और इष्टकिजीय क्षेत्रों में भी यह अच्छी रही है जिसके परिणाम कालान्तर में प्रकाशनार्थ भेजे जाएगे।

EFFECT OF FUNGICIDE TREATMENT OF SOIL ON MYCORRHIZAL DEVELOPMENT IN PINES

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Introduction

Many exotic tropical pines along with two indigenous hard pines, chir pine (*Pinus roxburghii*) and khasi pine (*P. kesiya*) are being raised in plantations both in natural pine zones as well as in states of Madhya Pradesh, Orissa, Tamil Nadu and Andhra Pradesh. These pines suffer seriously from damping off and root-rot pathogens in nurseries both in seed beds and in polythene bags. To protect pine seedlings from damping off and root-rot fungi in polythene bags, fungicides are either mixed with potting mixture or polythene bag soil is drenched with water suspension of fungicide when the diseases manifest in polythene bag seedlings. Mixing of fungicides with potting mixture is usually discouraged as such treatment is considered to adversely affect development of mycorrhiza on pine roots (Bakshi, 1974). Present experiment was conducted to see the effect of soil treatment with fungicides commonly used to control damping off and root-rot diseases on mycorrhizal development in pine roots.

Testing procedure

Potting mixture was prepared by mixing 3 parts of soil collected from underneath chir pine trees and one part sand. The soil contained active mycorrhizal roots. pH of the potting mixture was 6.5. Four fungicides, namely, dithane M-45 (a coordination product of zinc ion and manganous ethylenebis dithiocarbamate), blue copper-50 (copper oxychloride), brassicol (pentachloronitrobenzene) and captaf (N-trichloromethyl thio-4-cyclohexene-1-2 dicarboximide) were used in the experiment. For each fungicide, 0.15 m^3 of soil was treated with 50 g each of dithane M-45, blue copper and brassicol and 37.5 g of captaf. Potting mixture without fungicide treatment was used for control plants.

Two pine species, *Pinus patula* and *P. caribaea* were used as test species. Forty pine seedlings were used for each treatment. Four pine seedlings (two of *P. patula* and two of *P. caribaea*) were excavated at monthly intervals and seedling roots were examined for presence of mycorrhiza. Presence of well developed mantle and hartig net was taken as the criterion for the presence of mycorrhiza on roots. Experiments were done in a nursery in New Forest, Dehra Dun. Experiment were started in November/December 1983 and repeated in April, 1984. In November/December experiment, seeds were sown on 13.10.83 and seeds germinated on 27.10.83 in *P. caribaea* and 2.11.83 in *P. patula*. In April experiment seeds were sown on 7.3.84 and seeds germinated on 14.3.84 in both pines.

Table 1

Effect of fungicide treatment of potting mixture on mycorrhizal development in pines

Date of pricking	Test species	Test fungicide	Time taken for mycorrhizal development (days)
5.12.83	*P. patula*	Blue copper-50	217
		Captaf	182
		Dithane M-45	217
		Brassicol	No mycorrhiza upto 217 days.
		Control	166
30.11.83	*P. caribaea*	Blue copper	222
		Captaf	222
		Dithane M-45	222
		Brassicol	No mycorrhiza upto 222 days
		Control	171
21.4.84	*P. patula*	Blue copper	157
		Captaf	126
		Dithane M-45	126
		Brassicol	157
		Control	95
24.4.84	*P. caribaea*	Blue copper	123
		Captaf	No mycorrhiza upto 154 days
		Dithane M-45	
		Brassicol	
		Control	123

Conclusions

Following conclusions are drawn from the data presented in Table 1.

1. Mycorrhizal development in pine seedlings takes place 95-171 days after pricking seedlings in polythene bags in potting mixture without fungicide treatment.

2. Mycorrhizal development was earlier in April pricking (95-123 days) than in December pricking (166-171 days). Fungal activity during winter months in slow due to low temperature under Dehra Dun conditions and hence mycorrhizal development takes longer time. With rise in temperature, fungal activity gets accelerated and this helps in earlier development of mycorrhiza on pine roots during summer months.

3. Treatment of soil with fungicides has a depressing effect on mycorrhizal development in pine seedlings. Among different fungicides, brassicol appears to delay

mycorrhiza development longer than other fungicides. Treatment of soil with fungicides, however, did not affect viability of the mycorrhizal inoculum.

It is evident from the above that treatment of polythene bag soil with fungicides and mycorrhizal inoculation of the same can be done simultaneously for control of damping off fungi as well as for development of mycorrhiza in pine seedlings as fungicide treatment of soil does not affect viability of mycorrhizal inoculum though such treatment may delay the development of mycorrhiza to some extent.

SUMMARY

Treatment of potting mixture with fungicides (dithane M-45, blue copper, brassicol and captaf) was observed to delay mycorrhizal development in pine seedlings in experiment conducted in a New Forest Nursery though such treatment did not affect the viability of mycorrhizal inoculum. Treatment of polythene soil with fungicides and mycorrhizal inoculation of the same can therefore be done simultaneously for control of damping off fungi as well as development of mycorrhiza in roots of pine seedlings Mycorrhizal development was earlier in pine seedlings pricked in April than in those pricked in November-December.

चीड़ों के कवकमूल विकास में मृदा के कवकनाशी उपचार का प्रभाव

सुजान सिंह, एस०एन० मुकर्जी व सुरेश चन्द्र

सारांश

न्यूफारेस्ट रोपणी में किए गए संपरीक्षण में गमलों में कवकनाशी पदार्थ (डायथेन एम० 45, नीला तांबा, ब्रासिकोल और कैंपटेफ) मिलाने के उपचारों से चीड़ के पौधों में कवकमूल विकसित होने में विलम्ब पड़ता देखा गया, यद्धपि वन उपचारों से कवकमूलता टीके की जीविष्णुता पर कोई कुप्रभाव नहीं पड़ा। अतः चीड़ के पौधों की जड़ों में कवकमूल विकसित करने और पौधों की आद्रमरण नियंत्रित करने के लिए कवकमूलता टीका लगाने के साथ-साथ पोलिथीन मृदा का कवकनाशी उपचार भी कराया जा सकता है। नवम्बर-दिसम्बर में गमलों से निकाले गये पौधों की तुलना में अप्रैल में निकाले गये चीड़ के पौधों में कवकमूल विकास अधिक जल्दी हुआ।

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SPECTRAL PROPERTIES AND COLLOIDAL BEHAVIOUR OF THE HUMIC ACIDS OF THE SOILS UNDER OAK (*QUERCUS INCANA*), DEODAR (*CEDRUS DEODARA*) AND CHIR (*PINUS ROXBURGHII*) OF MUSSOORIE HIMALAYAS (U.P.)

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Introduction

In soils the humic substances are represented by a system of polymers which vary in its chemical nature and size according to the type of soil and the vegetation it supports. Of the two the chemical nature is of greater importance. It is expressed in terms of functional groupings, optical behaviour in U.V. and visible regions and coagulation threshold values. The functional groupings determines the chemical nature of the humic substances, the optical behaviour reflects on the degree of aromatisation in them (Kononova, 1966) and the degree of dispersion characterises its behaviour towards electrolytes. The later also influences translocation of humus substances and their organo mineral compounds in the formation of structure in soil. A comparative determination of the optical properties and behaviour towards electrolytes of humic acids of soils under different vegetation was done by Springer (1938) who observed a regular pattern of differences in the nature and the properties of humic acids. Banerjee and Mukherjee (1972) studied the optical densities and the behaviour towards electrolytes of humic acids of some Assam soils. Ghosh *et al.* (1977), studied the optical properties and colloidal behaviour of certain forest soils of tropical dry deciduous forests. However, no such work has been reported for the soils of Himalayan region which have different types of soils under different sets of vegetation Hence in order to understand the nature and properties of the humus substances and to characterise them for the proper forest management, the soils of Mussoorie Himalayas (U. P.) under different set of vegetation and parent materials have been investigated.

Material and Methods

Soils for the present study were collected from the Dhanaulti block of Yamuna Forest Division (U P.) which is situated in the south of Mussoorie between altitude 2000 m to 2375 m above msl. The average annual rainfall of the area is 254 cm with maximum of 75.21 cm in August and minimum of 0.41 cm in November. The mean maximum and minimum temperature for the hottest months are 30°C and 16°C and for the coldest months 9.4°C and 3.8°C respectively. The predominating species of the area are Oak (*Quercus incana*), Chir (*Pinus roxburghii*) and Deodar (*Cedrus*

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deodara) inter mixed with Buran (*Rhododendron arboreum*), Anyar (*Lyonia ovalifolia*), Ruins (*Coteneaster bacillaris*) and Kimgor etc. The main parent rocks are phylites, shales and sand stones under Deodar and Chir covers and quartzites and slates under Oak cover. The microbial activity remains supressed during the cold and dry season and the humified material dries and coagulates during this period but in spring season the microbial activity revives and the process of decomposition starts. The soil character.stics in brief are given in Table 1.

Experimental

For the determination of optical properties and coagulation threshold values the humic acids were extracted from the soils by the mixture of sodium-pyrophosphate-sodium hydroxide solution following the rapid method of Kononova and Belchikova (1961) and dissolving in 0.05 N sodium carbonate to a volume to represent carbon concentration of 0.136 g/l at pH 8 5. The optical density of humate solutions was determined in the visible region of the spectrum and spectro-photometric curves obtained between the wavelengths 456 to 800 mμ with the help of spectronic-20 Spectrophotometer. The coagulation threshold values were determined with calcium-chloride as the electrolyte. The time in hrs and the corresponding amounts of electrolytes (m.e/l) for complete coagulation i.e. when the solution above the coagulum became transparent was recorded for each sample.

Results and Discussions

The values of optical density differ considerably from profile to profile and also with in the same profile depending upon the vegetation they support and the depth of accumulation. The ratio of these densities at 465 mμ and 665 mμ (E_4E_6), independent of concentrations of humic material has been used here as characteristic of humic substances. They have been found negatively correlated (r= —0.3) with the organic carbon of the soil (Fig. 1). It can be seen that the ratio is highest for the profiles under Chir (*Pinus roxburghii*) and lowest under Oak (*Quercus incana*). Deodar (*Cedrus deodara*) falls between the two to indicate high degree of condensation of aromatic rings in humus of Deodar and lowest in Chir. This also indicate that the humic acids of soils under Chir is of more aliphatic nature as compared to Oak and Deodar (Table 1).

It can be seen that the humus of sub-surface is more humified, condensed and aromatised in comparison to the surface samples as reflected by their lower E_4/E_6 ratios, steep absorption curves (Fig. 2 and 3) and lower requirement of electrolyte for starting and completing coagulation.

The behaviour of humic acids towards electrolytes has been determined by the degree of dispersion of humic acids. It is also inversely related with the aromatic to aliphatic structures ratio of the humic acid molecules. The aromatic part has been hydrophobic in aqueous medium and susceptible to coagulatian. The hydrophillic aliphatic part has however coagulated in aqueous medium. It can be seen that

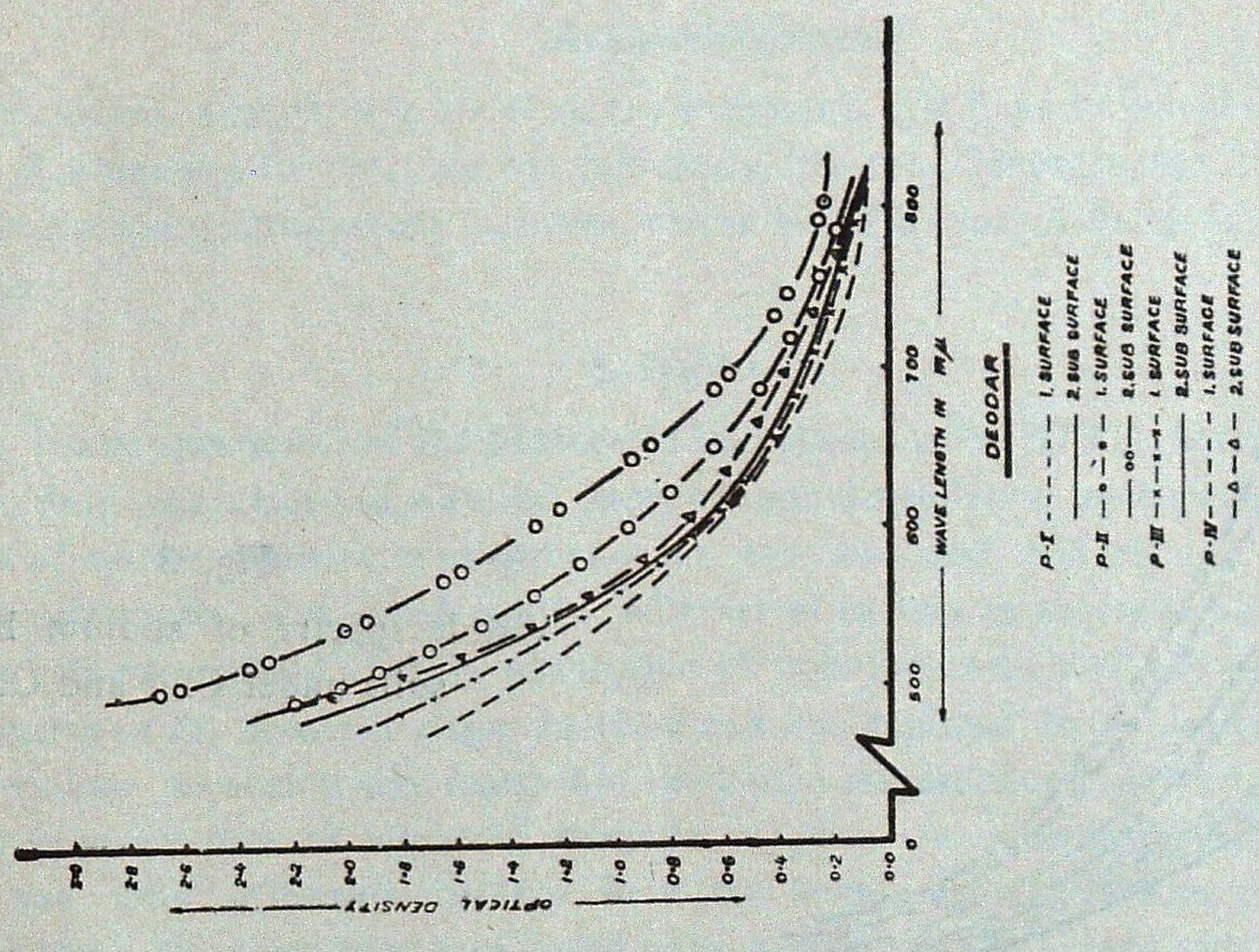
stability of humic acids of Deodar and Oak towards electrolytes ($CaCl_2$) is less as compared to Chir as indicated by the rapid coagulation of the humic acids of the former (Table 2). It also indicates that the nature of the humic acids of Deodar and Oak is of hydrophobic nature due to lower threshold values and as such more suitable for the formation of favourable aggregates in the soil.

Table 1

Optical density of solutions of the humates (carbon concentration—.136 g/l)

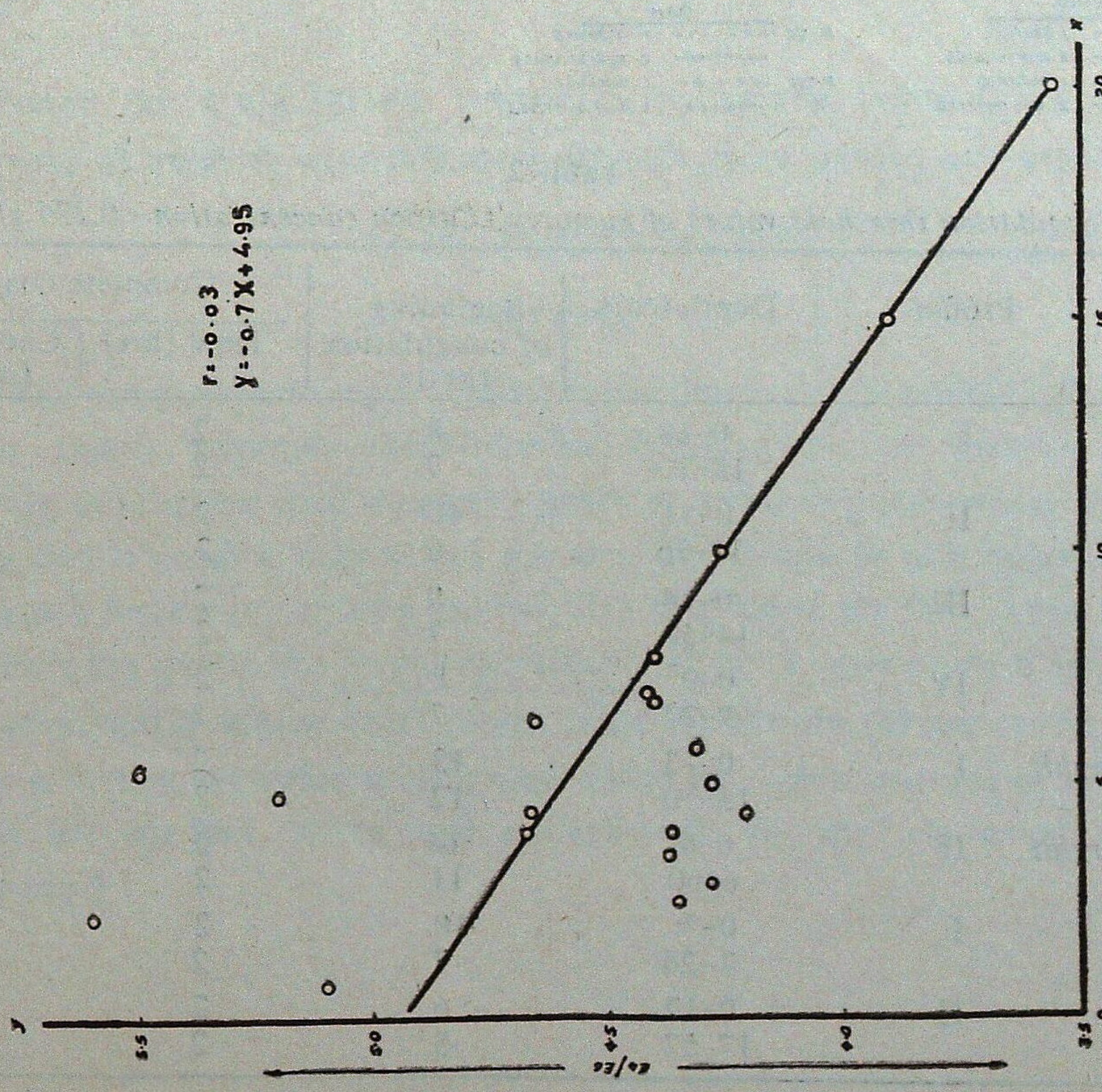
Vegetation	Profile	Depth (cm)	Values of optical density at wave length mμ						
			465	500	600	665	700	800	E4/E6
Cedrus deodara	I	0-18	2.2	1.4	.62	.50	.25	0.09	4.40
		18-70	2 4	1.8	.65	.55	.32	0.13	4.36
Cedrus deodara	II	0-11	2.8	2 0	.93	.60	.40	0.16	4.66
		11-36	3.0	2.6	1.3	.70	.55	.23	4.28
Cedrus deodara	III	0-14	2.3	1.6	.64	.52	.28	0 11	4.42
		14-50	2.4	1.8	.65	.55	.32	0.13	4.36
Cedrus deodara	IV	0-9	2.2	1.4	.62	.50	.25	0.9	4.40
		9-22	2.5	1.9	.70	.58	.38	0.15	4.31
Pinus roxburghii	I	0-13	1.5	1.1	.50	.27	.22	0.09	5.5
		13-50	1.3	1.0	.48	.25	.20	0.07	5.2
Pinus roxburghii	II	0-6	1.7	1.2	.52	.32	.25	0.011	5.6
		6-60	1.8	1.3	.54	.35	.28	0.01	5.1
Quercus incana	I	0-7	2.8	2.0	.93	.60	.40	0.16	4.66
		7-24	2.4	1.8	.65	.55	.32	0.13	4 36
Quercus incana	II	0-17	3.0	2.6	1.3	.70	.55	0.23	4.28
		17-57	3.2	2.9	1.4	.75	.58	0.25	4.20

Fig. 2



Visible spectra of sodium humates soils under Deodar

Fig. 1



Relationship between E_4/E_6 ratio and organic matter in soils.

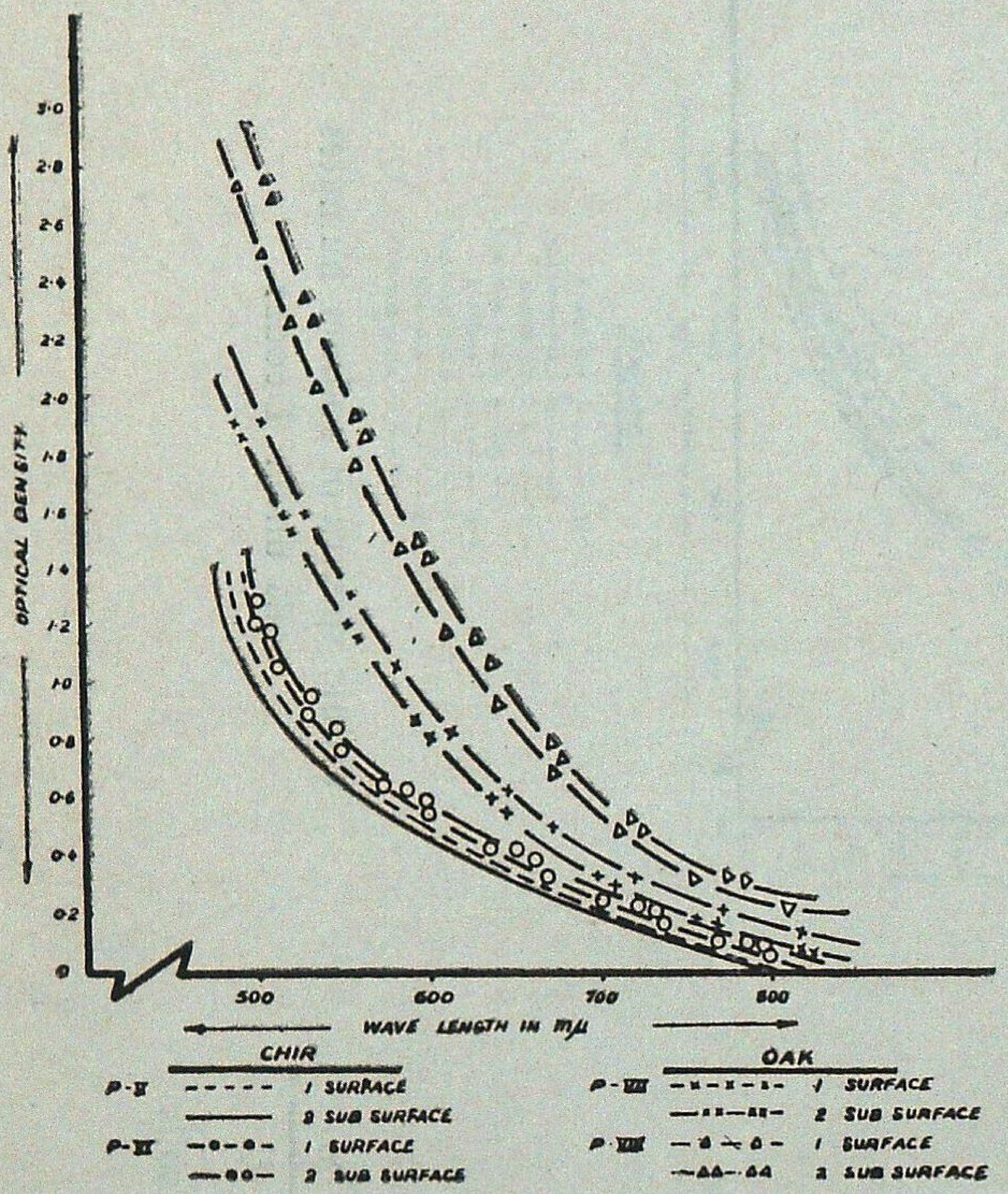


Fig. 3

Visible spectra of sodium humates soils under Chir and Oak.

Table 2

Coagulation threshold values of humates (*Carbon concentration—0.136 g/l*)

Vegetation	Profile	Depth (cm)	Beginning of coagulation (hrs)	Complete coagulation	
				Time (hrs)	$CaCl_2$ regd. (m.e/l)
Cedrus deodara	I	0–18	8	2	14
		18–70	7	2	13
Cedrus deodara	II	0–11	10	2	16
		11–36	6	2	12
Cedrus deodara	III	0–14	9	2	15
		14–50	7	2	13
Cedrus deodara	IV	0–9	8	2	14
		9–22	7	2	11
Pinus roxburghii	I	0–13	13	2	17
		13–50	12	2	16
Pinus roxburghii	II	0–6	14	2	19
		6–60	11	2	15
Quercus incana	I	0–7	10	2	16
		7–24	7	2	13
Quercus incana	II	0–17	6	2	12
		17–57	5	2	10

Acknowledgements

The junior author is grateful to the President, F.R.I. and Colleges for the award of a post M.Sc. Scholarship for carrying out this study, to the Co-ordinator F.S.V.S., F.R.I. & Colleges for providing laboratory facilities, to the F.S.V.S. Survey Party for help in collecting soil samples.

SUMMARY

The humic substances of the Mussoorie Himalayan soils (U.P.) under different vegetation covers, were characterised with the help of non-degradative spectrophotometric methods. The ratios of optical densities or absorbance at 465 mμ and 665 mμ. in respect of dilute aqueous humic acids was used as the indicator of carbon in aromatic nuclei and in aliphatic side chains. It was noticed that the absorption of light increased with the increase in the degree of condensation of the aromatic rings in them and was depicted by a lower E_4/E_6 ratios and lesser absorptions. As such it was found that the humic substances under Chir (*Pinus roxburghii*) contain large proportion of aliphatic structure in them in comparison to Deodar (*Cedrus deodara*) and Oak (*Quercus incana*) were the humic substances were more condensed with aromatic rings. The later were also found to be hydrophobic in nature with lower coagulation threshold values as compared to former and as such were more akin for the favourable soil aggregation.

मसूरी, हिमालय क्षेत्र में बांज (क्वेरकस इनकाना), देवदार (सीडरस डिओडारा) और चीड़ (पाइनस राक्सबर्घिआई) की मृदाओं की वर्णगत विशिष्टनाएँ और उनके ह्यूमिक(धरणिक) अम्ल का क्षाराभ व्यवहार

आर०एम० सिंहल और एस० सोनी

सारांश

विभिन्न वनस्पतियां लगी मसूरी, हिमालय मृदाओं (उत्तर प्रदेश) के धरणिक (ह्यूमिक) पदार्थों का अनपचयोन्मुख रंगाबली प्रकाशमापन (स्पेक्ट्रोफोटोमीटिक) रीति द्वारा लक्षण लेखन किया गया। 465 म्यू और 665 म्यू पर तनू जलीय धरणिक अम्लों की प्रकाशीय सघनता का अनुपात या प्रचूषण सुगन्धित नाभिक (न्यूक्ल) तथा स्नेहिक पार्श्व श्रृंखलाओं में कार्बन के सूचक माने गए। देखने में आया कि उनमें सुगंधित छल्लों के सघनन की मात्रा बढ़ने से प्रकाश प्रचूषण भी बढ़ता गया जिसे निम्न $ई_4/ई_6$ अनुपात और निम्न प्रचूषण से सूचित किया गया। इस प्रकार ज्ञात हुआ कि चीड़ (पाइनस राक्सबर्घिआई) की मृदा के धरणिक अम्ल में स्नेहिक संरचना का समानुपात अधिक रहता है बनिस्बत देवदार (सीडरस डिओडारा) और बांज (क्वेरकस इनकाना) की मृदाओं के अम्ल के, जिनके धरणिक तत्व सुगंधित छल्लों से अधिक संघनित हुए। इनके अम्ल उपर्युक्त अम्ल की तुलना में प्रकृति से जल भीरु और निम्न आतंचन देहली अर्हा वाले पाये गए और इस कारण मृदा समूहन की अनुकूलता के बन्धु हैं।

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RECENT ADVANCES IN FOREST MICROCLIMATE RESEARCH IN INDIA

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Introduction

In the study of the inter–relationship between environment and plant community, the conditions that prevail very close to the ground is of considerable significance (Qureshi & Subba Rao, 1964). This is particularly true in the case of influences of vegetation cover on local climate which is usually referred to as 'Microclimate'. Among various complex environmental factors influencing the plant life, temperature and moisture status of soil are two important factors influencing growth and development (Seth *et al*., 1967). A plant is very sensitive to climate in its formative years. The various physiological processes of plant life are influenced by various components of microclimate such as air and soil temperatures, humidity, soil moisture etc. The processes of germination, water and nutrient absorption, transpiration etc., are also governed by temperature and moisture conditions. Microclimatic conditions also exert influence on the microflora and fauna within the cover and hence on the life of insect pests and fungal diseases as well. Thus, the climate close to the forest floor plays an important role in case of plantations for their survival, establishment and growth. Microclimatological studies in India so far have been mostly carried out in respect of agricultural crops or in forest plantations. The Forest Influences Branch of F.R I. and Colleges, Dehra Dun has been engaged in forest microclimatological studies since last 25 years. A number of pilot studies have been carried out particularly on microclimate of forest plantations at New Forest, Dehra Dun. Important among them are studies in chir pine and bamboo (Dabral *et al*., 1969) and the study of the microclimate of forest plantations at FRI by Seth *et al*. (1967).

A comprehensive review of all the studies carried out in India upto 1981 in the field of 'Forest Influences' has been done by Ghosh *et al*. (1982). This review presents the present status of research on environmental effects of forests in India.

Recently, Subba Rao and Pande (1982) have studied the role of litter cover in modifying the climate close to the forest floor. The soil climate and the climate close to the forest floor are affected to a great extent, *inter alia* by the nature and composition of the surface layer which, in turn is affected by the litter produced by the forest itself. The forest as a source of forest floor affects the depth and character of 'A' horizon the content of soil moisture,

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the content of organic matter, the colour of soil surface and surface radiation (Mohar and Van Baren, 1954). The studies by Subba Rao and Pande (1982) were carried out during 1966-69, mainly to understand the role of litter on the climatic conditions close to the forest floor including soil moisture and soil temperature in chir (*Pinus roxburghii*), sal (*Shorea robusta*) and teak (*Tectona grandis*) forest plantations (Table 1) and the conditions inside the plantations have been compared with those obtained in open. The studies have shown that the forest cover has a moderating influence on both the air and soil temperatures by raising the lower morning temperatures (blanketing effect) and lowering the higher afternoon temperature (sheltering effect). The litter cover enchances the moderating effect to a small extent.

The effect on the morning air temperatures is blanketing during the cold winter months and slightly sheltering during summer and rainy season. Maximum blanketing effect is of the order of 8 degrees in chir (March), 7 degrees in sal (March) and 6 degrees in teak (March). Maximum blanketing effect due to litter cover only is 0.5 degrees in chir (Nov.), 2.2. degrees in sal (Feb.) and 1.7 degrees in teak (Feb.). Maximum sheltering effect due to forest cover on morning air temperatures is 0.9 degrees in chir (May), 1.7 degrees in sal (June) and 1.8 degrees in teak (April). Maximum sheltering effect due to litter cover alone on morning air temperatures is 0.3 degrees in chir (April), 1.5 degrees in sal (Jan.) and 1.4 degrees in teak (Feb.) The morning humidities inside the plantations are generally lower or higher due to blanketing or sheltering effect respectively.

The maximum sheltering effect on afternoon air temperature is 8.5 degrees in chir (Nov.), 10 degrees in sal (Feb.) and 9 degrees in teak (Nov.). Maximum sheltering effect due to litter cover alone is 0.6 degrees in chir (April), 1.2 degrees in sal (Oct.) and 2.8 degrees in teak (April).

The effect of forest cover on the

Table 1

The characteristics of three plantations.

Plantations	Year of plantation (Age)	No of trees/ha	Av. height (m)	Av. diameter (cm)	Crown density (%)
Pinus roxburghii (Chir)	1926 (40–44)	555	24.6	22.2	81
Shorea robusta (Sal)	1926* (40–44)	1473	17.2	17.1	86
Tectona grandis (Teak)	1927 (39-43)	666	22.3	24.5	90

*Coppiced in 1948.

morning soil temperatures is generally blanketing during winter (maximum effect is 4.6 degrees in chir and sal (Dec.) and 5.7 degrees (Dec.) in teak) and sheltering during summer and rainy season which is 8.1 degrees in chir (May), 9.5 degrees in sal (May) and 5.0 degrees in teak (May).

Maximum sheltering effect on morning soil temperatures due to litter cover alone is 1.2 degrees in chir (June), 1.5 degrees in sal (May) and 1.1 degrees in teak (May) and maximum blanketing effect is 1.6 degrees in chir (Jan.) 2.6 degrees in sal (Jan) and 0.7 degrees in teak (Nov.).

The combined effect of forest and litter covers on the afternoon soil temperatures is sheltering throughout the year in all the three plantations. The effect is maximum during the summer months and least during the rainy season. Maximum sheltering effect due to forest cover on afternoon soil temperature is 25.5 degrees in chir (April), 26.3 degrees in sal (April) and 22 9 degrees in teak (April) and due to litter cover alone is 5.3 degrees in chir (May) 6.6 degrees in sal and 7.0 degrees in teak (April).

Both forest cover and litter cover have the conserving effect on soil moisture. Soil moisture is always higher by 2 to 3 per cent in chir, 1 to 4 per cent in sal and 1 to 6 per cent in teak inside the plantation than in open. The conserving effect of litter cover alone in the plantations is comparatively small (0 to 1 per cent in chir, 1 to 2 per cent in sal and 2 to 3 per cent in teak).

Figure 1 shows that, in sal plantations, the soil moisture in plots with litter (B) and without litter (A) are invariably higher than that in open (C). In Fig. 2, the curves of 5-weekly moving average soil moisture percentages in open and without litter are very close to each other. The combined effect of both forest cover and litter cover are more pronounced during rainy season but are comparatively small during the summer and winter seasons. In fact, during winter the soil moisture in open is higher than inside the plantations. The reason is not clear. This cannot be attributed to the ground flora as the study plots were free from any undergrowth. Possibly dew (or frost) condensed in open may be one of the contributing factors. Earlier studies have shown that the dew inside the forest is negligible From Figs. 3 and 4, it can be seen that the general behaviour of surface soil temperature in morning (0700 hrs) and afternoon (1400 hrs) is very similar in both open and inside the plantations. Considering the morning temperatures, the effect of tree and litter cover is that of blanketing (maximum 4.6 degrees) on lower winter temperatures and that of sheltering (maximum 9.5 degrees) on higher temperature during summer and rainy seasons. On the afternoon temperatures, however, the effect of tree and litter cover is that of sheltering throughout the year (Fig 4), maximum being over 26.3 degrees in April.

Fig. 5 shows the behaviour of average soil moisture in teak plantation. The 5-weekly moving average of soil moisture percentage has been plotted in Fig 6. The soil moisture in plots without litter is higher than in open and that with litter is higher than without litter. The average values of soil moisture percentage in all the cover conditions in different seasons also have

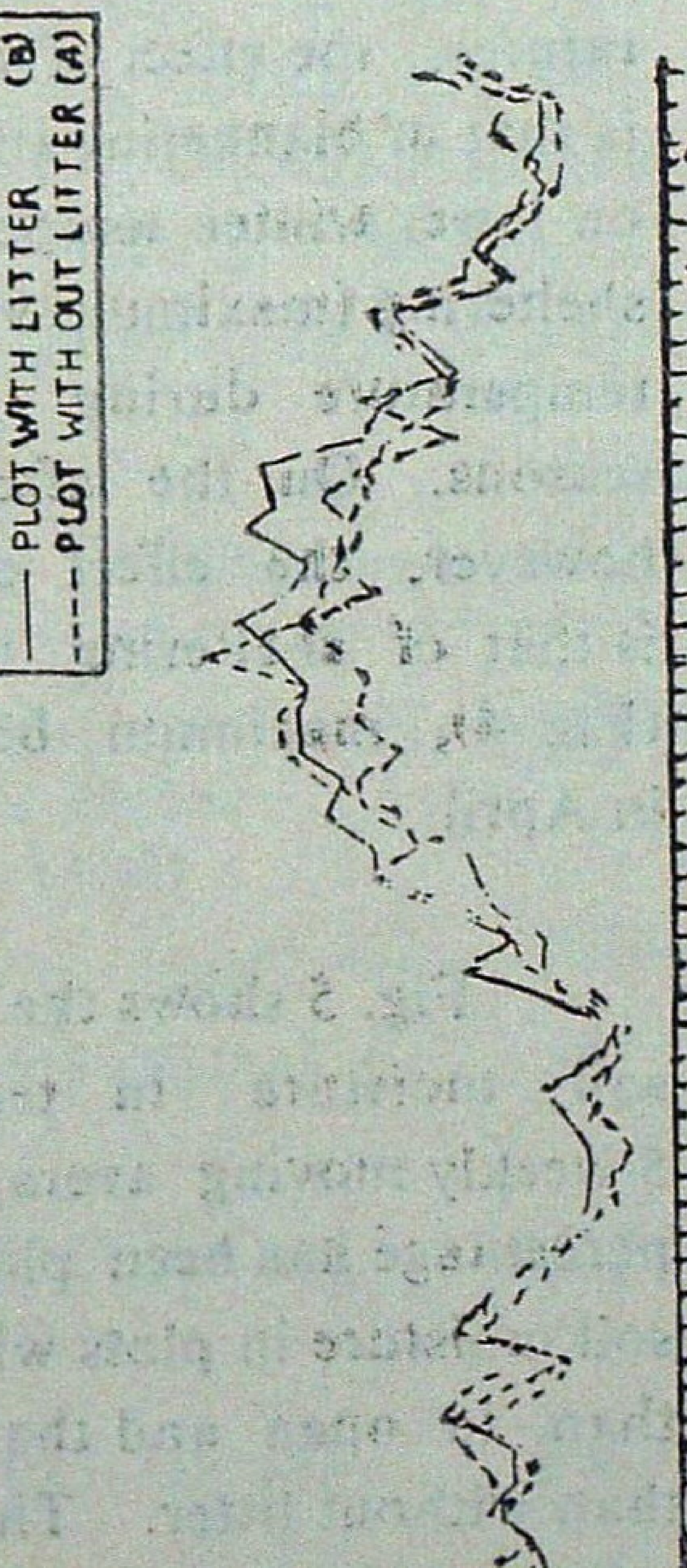


Fig. 1
Average soil moisture (%) in open and in Sal plantation (1966-69)

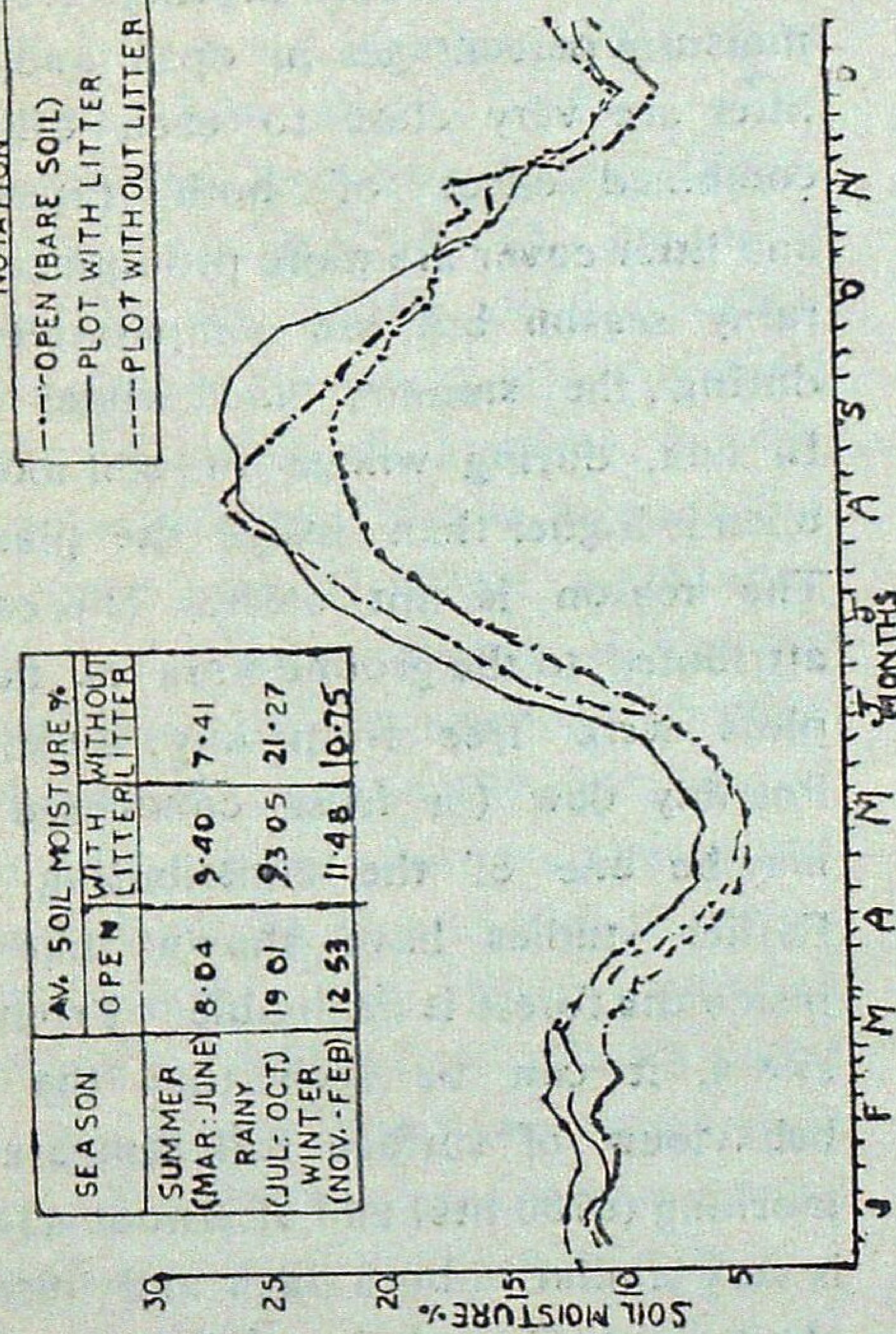


Fig. 2
Average soil moisture % in Sal plantation

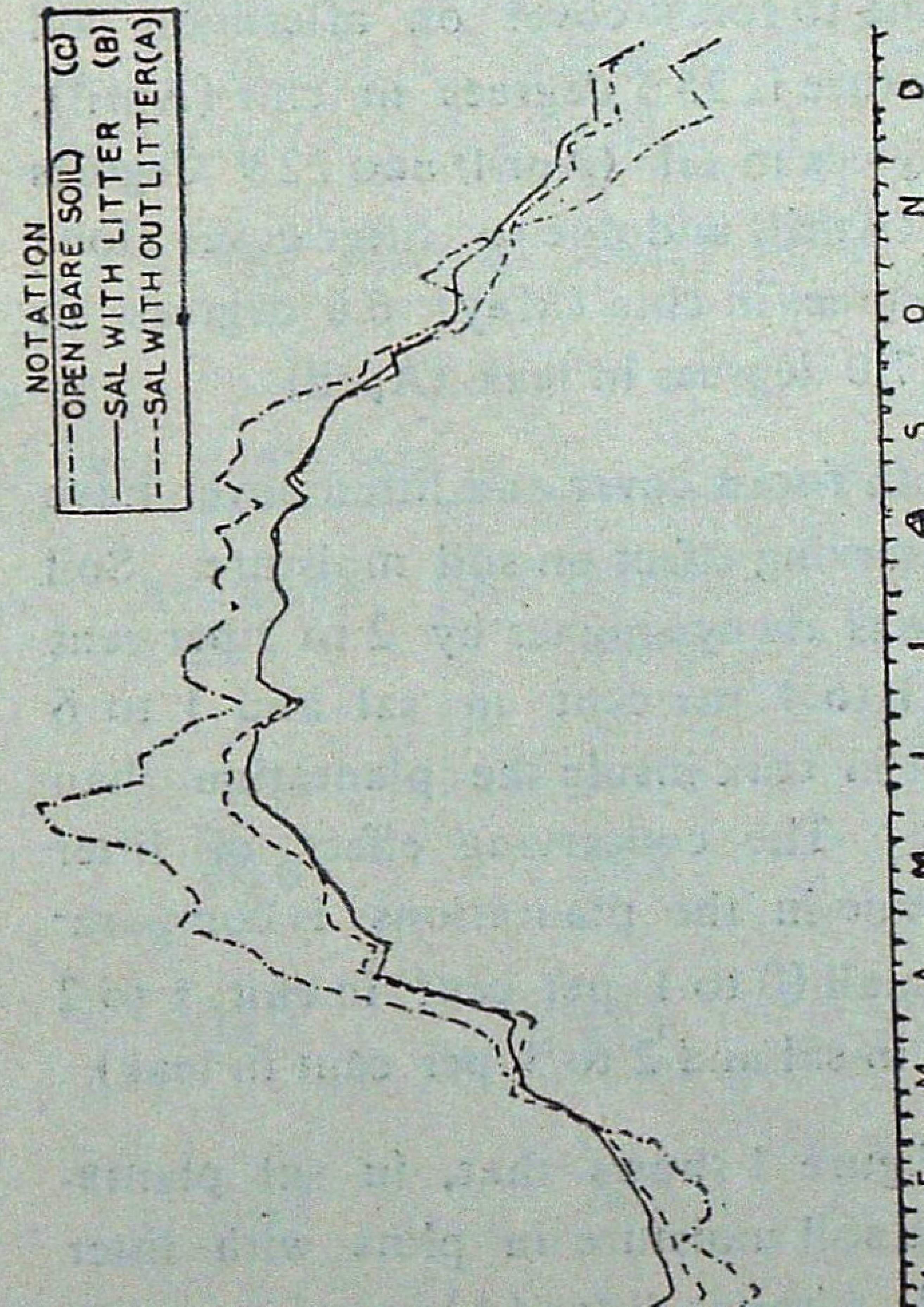


Fig. 3
Average surface soil temperature in open and in Sal plantation (1966-69) 0700 hrs.

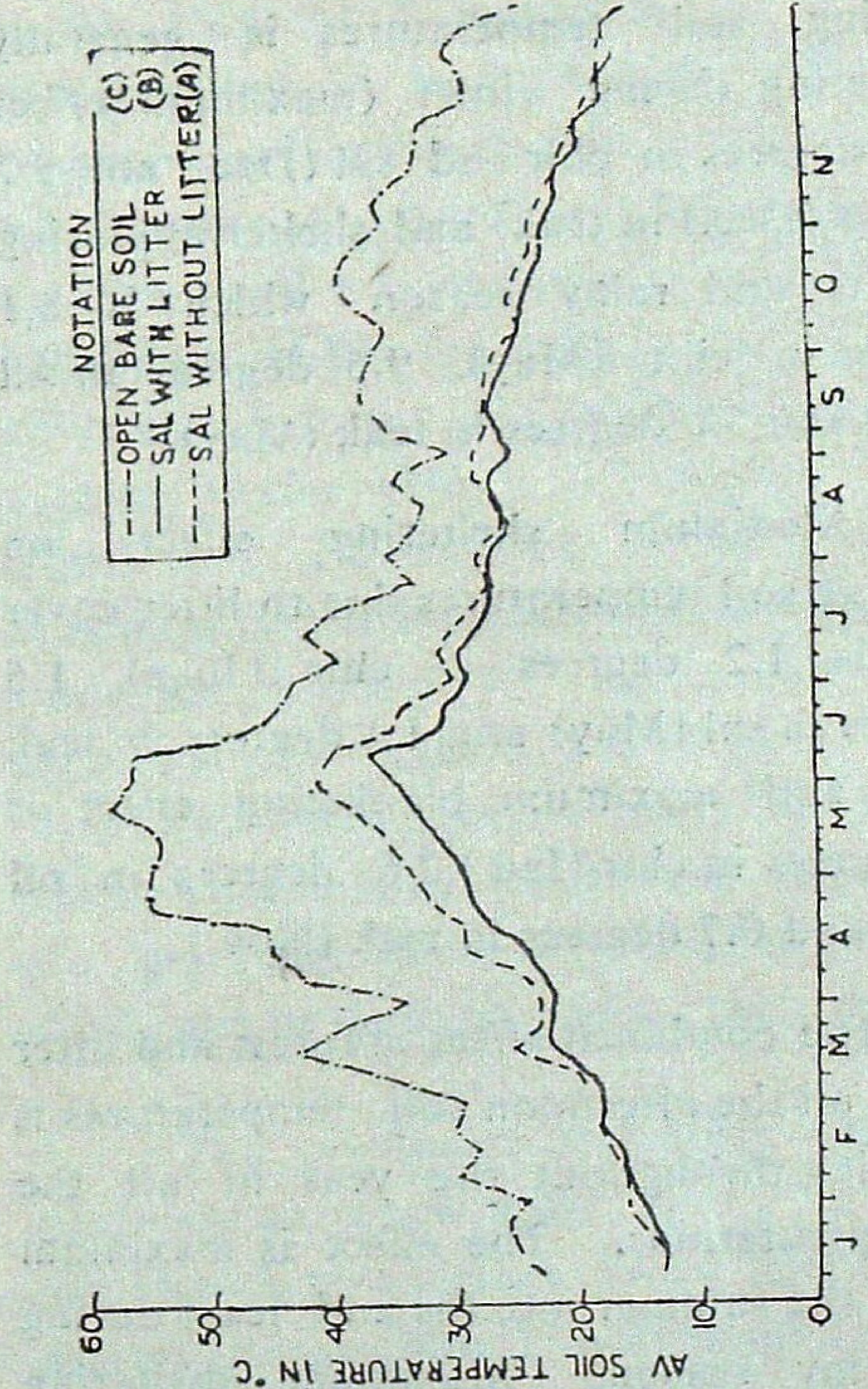


Fig. 4
Average surface soil temperature in open and in Sal plantation (1966-69) 1400 hrs.

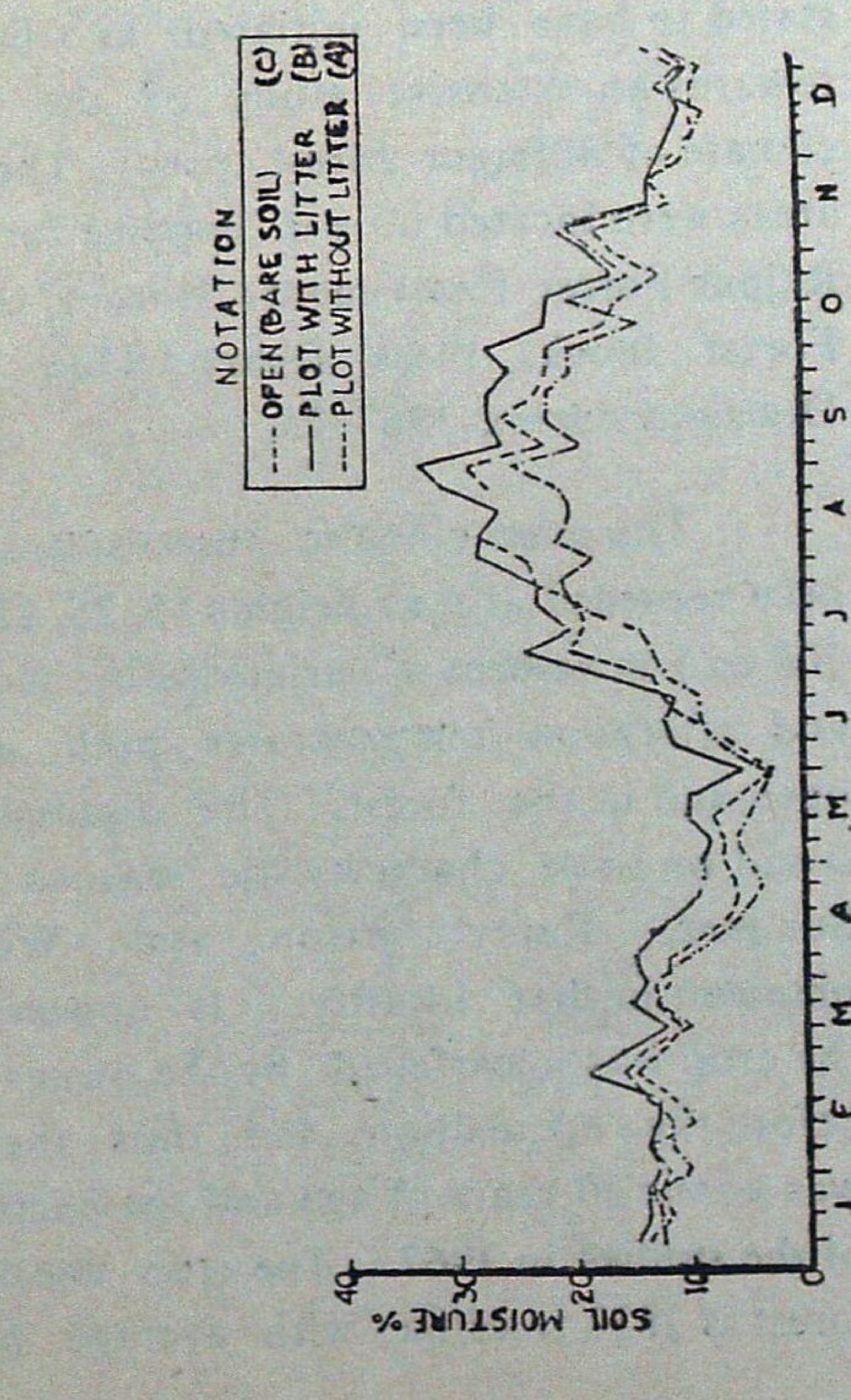


Fig. 5
Average soil moisture (%) in open and in Teak plantation 1966-69.

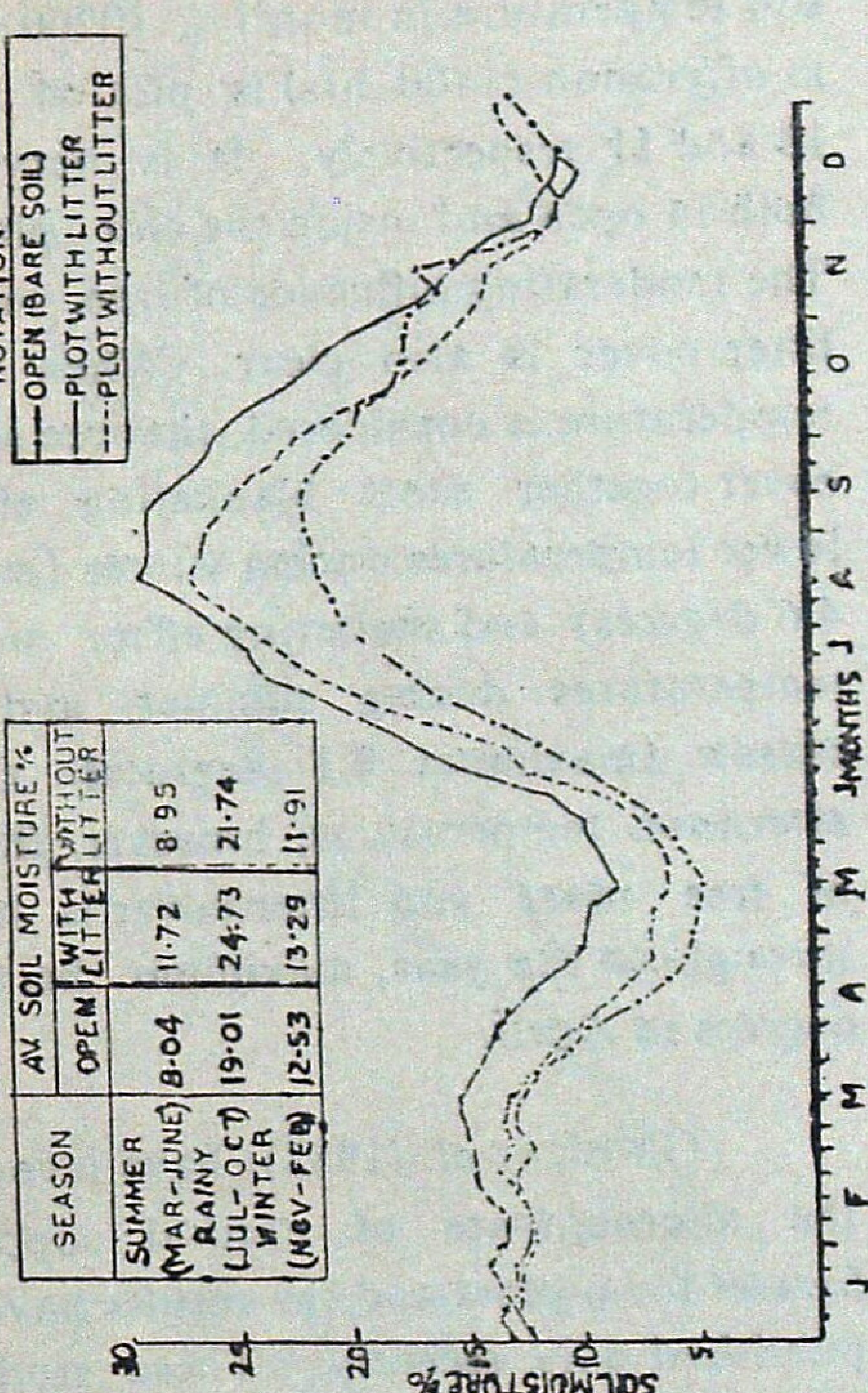


Fig. 6
Average soil moisture % in Teak plantation.

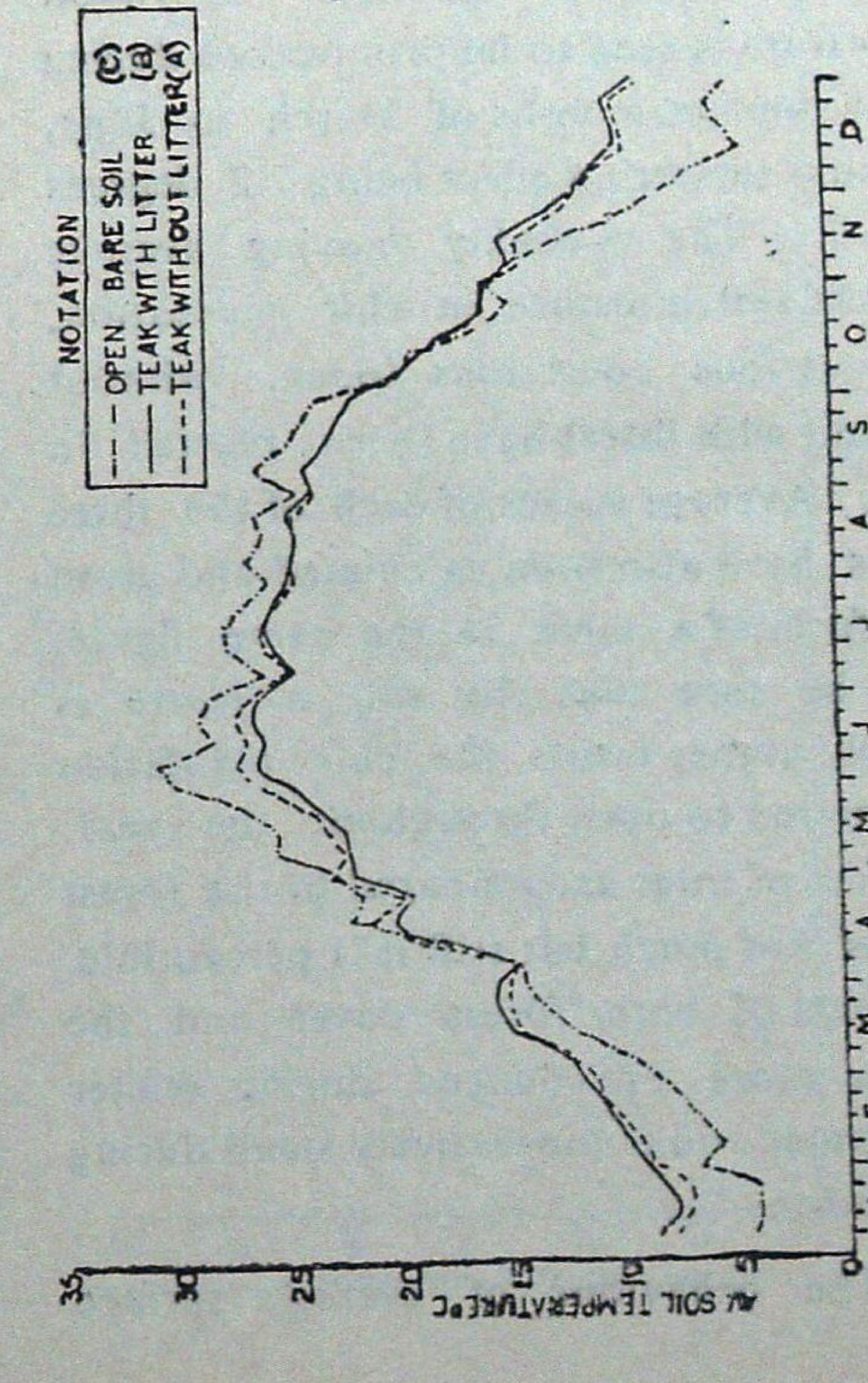


Fig. 7
Average surface soil temperature (%) in open and in Teak plantation (1966-69) 0700 hrs.

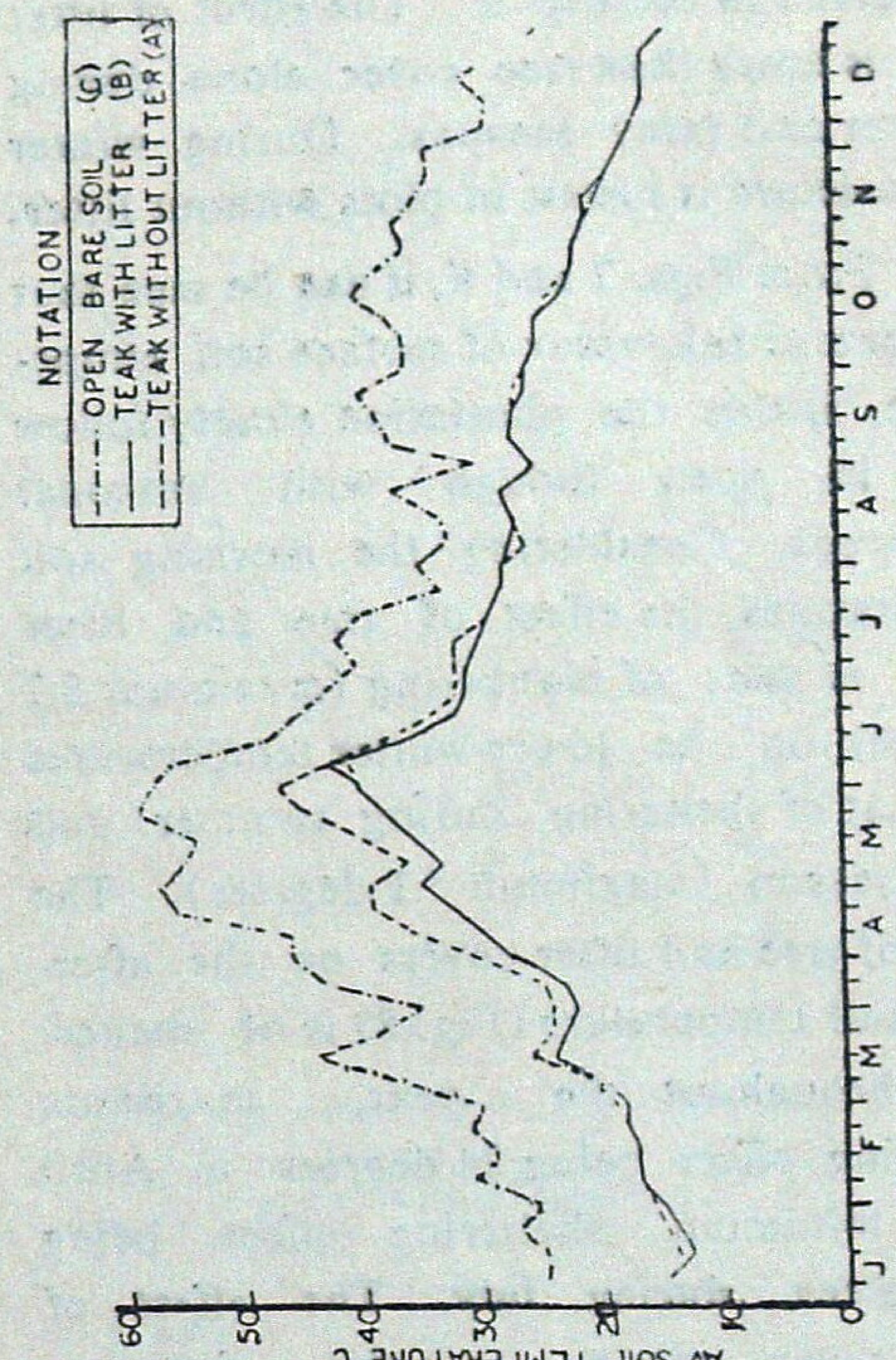


Fig. 8
Average surface soil temperature in open and in Teak plantation (1966-69) 1400 hrs.

been given in the Fig. 6. The effect of litter cover is more than tree cover alone during summer and rainy seasons. During winter soil moisture is lowest in plots without litter.

From Figs. 7 and 8, it can be seen that the general behaviour of surface soil temperature, inside the plantation closely follow that in open though with seasonal differences. Considering the morning soil temperatures, the effect of tree and litter cover is that of blanketing (maximum 5.7 degrees) on the lower winter temperatures and that of sheltering during summer and rainy season (maximum 5.1 degrees). The effect of tree and litter covers on the afternoon soil temperature (Fig. 8) is of sheltering throughout the year, maximum sheltering effect being 24 degrees in April and minimum sheltering effect being 5 degrees during July. The effect of tree cover alone on the afternoon temperature is seen to be pronounced during the hot summer months of March to June, maximum sheltering effect being 7.2 degrees in April. The 5-weekly moving average values of soil moisture in chir plantation, under various conditions (open, without litter and with litter) have been plotted in Fig. 9. Average values of each of the three seasons have also been calculated and given in the form of a table in the same figure. It can be seen that the soil moisture is generally higher inside the chir plantation as compared to open throughout the year. The effect of litter as compared to the forest cover is not much but still it is perceptible. The effects of both forest cover and the litter are more pronounced during winter and summer and comparatively small during rainy season.

The behaviour of average surface soil temperature in morning (0700 hrs) and in afternoon (1400 hrs) is plotted in Fig. 10 and 11 respectively. It is very similar both in open and inside the chir plantation. The moderating influence of tree cover and litter cover is also clear. When morning temperature is considered, the tree and litter cover together exert blanketing effect on lower temperatures during winter (maximum 4.6 degrees) and sheltering effect on higher temperatures during summer and rainy season (maximum 8.1 degrees). On the afternoon temperatures, however the effect of tree cover and litter cover is sheltering throughout the year, maximum being 25.5 degrees in April.

Ghosh *et al.* (1983) have investigated the microclimate of natural coppice sal forests for 6 years and the results have been published only recently. These studies are stated to have been initiated as a first step towards an extensive study of the microclimate of different forest types The study areas were located in sal coppice forest at Rajpur Forest Experiment Station (Rajpur Forest Block, West Dehra Dun Forest Division) during 1967-73.

The microclimatic observations have been recorded at four heights (5, 25, 122 and 200 cm) in respect of variations in morning and afternoon temperatures both in the open and in the forest. The discussion is based on three characteristic seasons (viz., Summer, Rainy season and Winter) obtained in that locality. It appears that the crop was clearfelled by the owner just before the acquisition and thus the crop was about 30 years of age and the beginning of the studies in 1967. The crop density of forest is 2637 trees/ha with average height

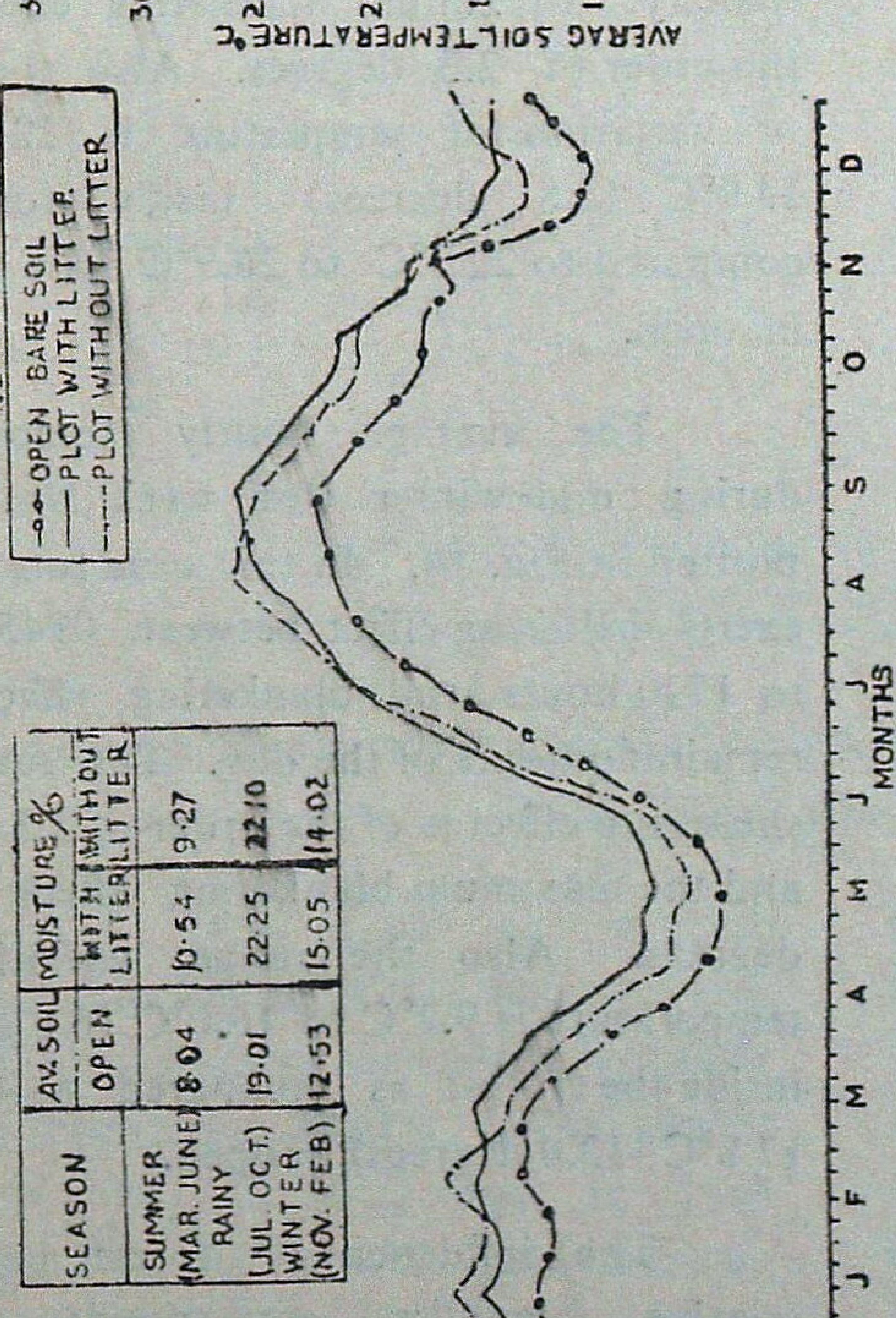


Fig. 9
Average soil moisture % in Chir plantation

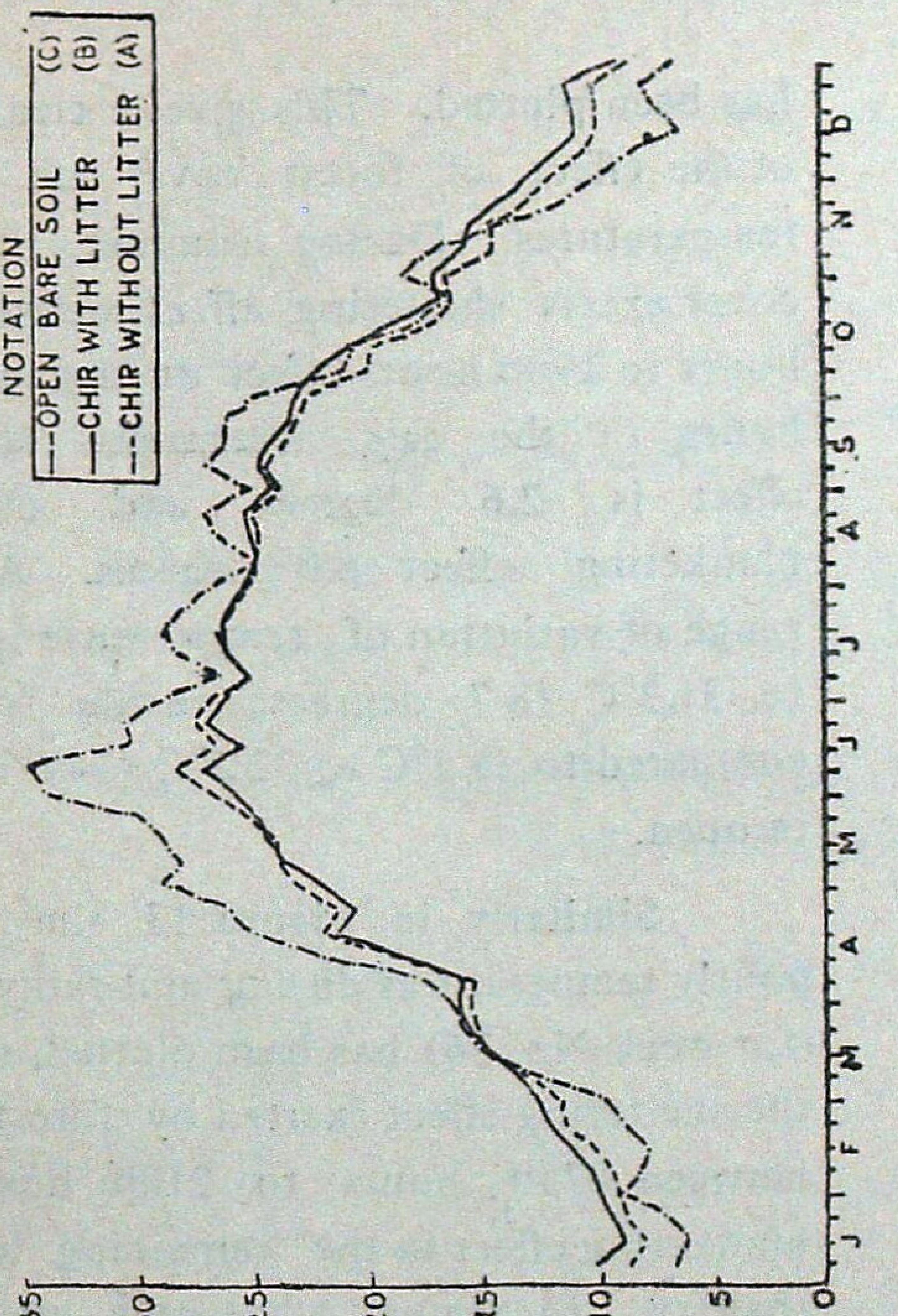


Fig. 10
Average surface soil temperature in open and in Chir plantation (1965-69) 0700 hrs.

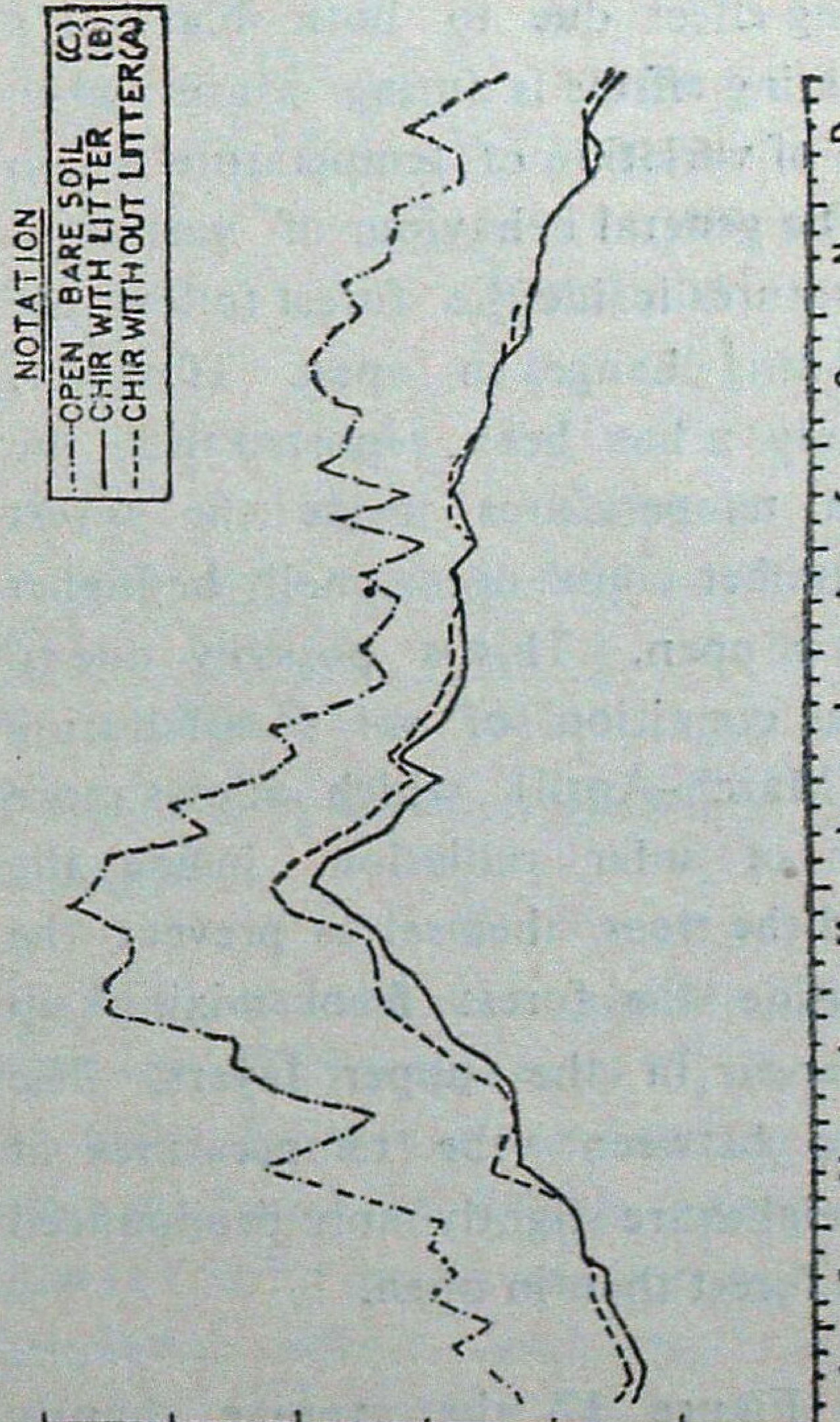


Fig. 11
Average surface soil temperature in open and in Chir plantation (1966-69) 1400 hrs.

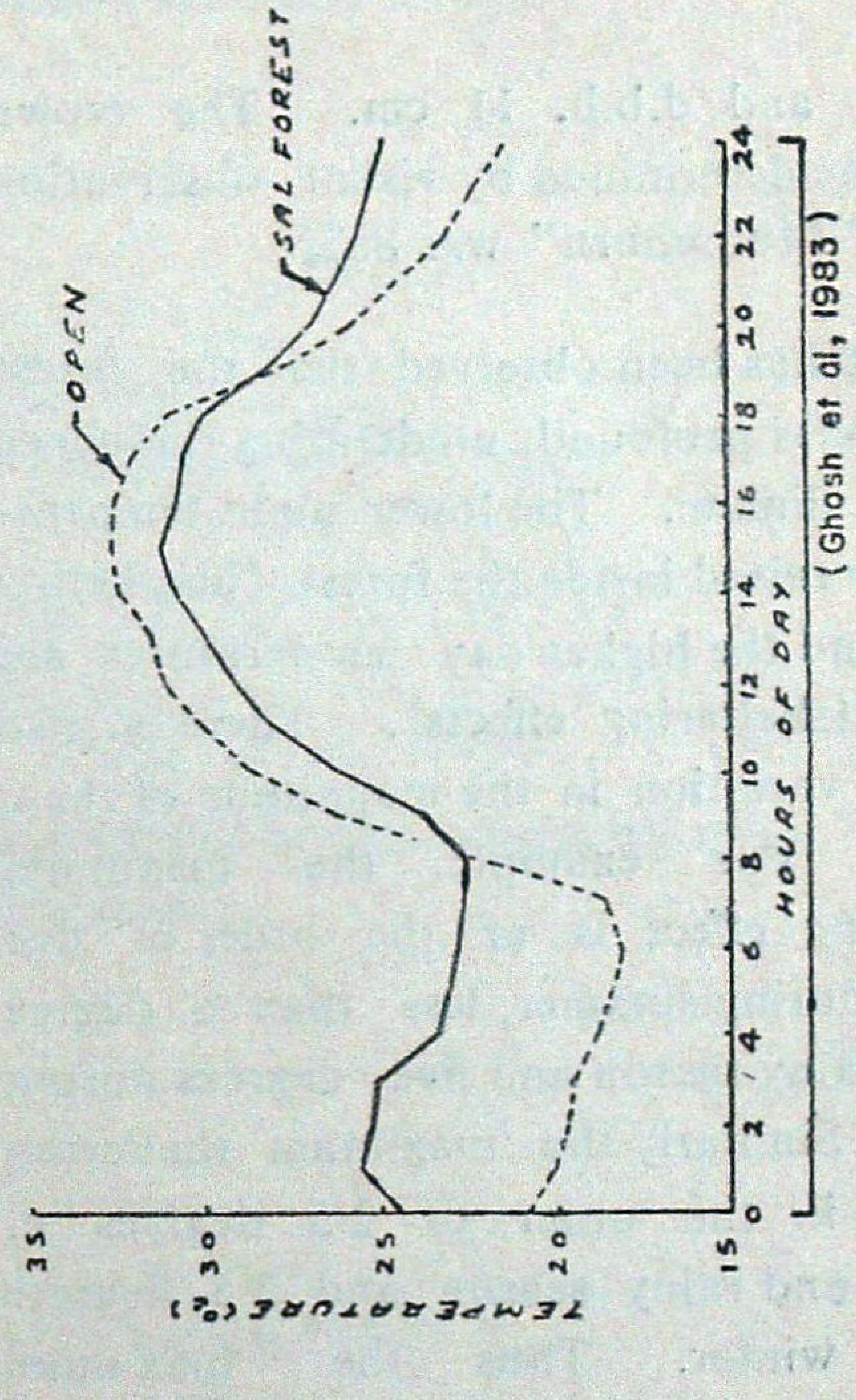


Fig. 12
Average hourly temperature (°C) 1967-73, recorded by thermohygrograph. Week No. 18, summer season.

of 12 m and d.b.h. 11 cm. The crown density as determined by visual observation using a "Moosehorn" was 88%.

It has been observed that the forest cover exerts profound moderating influence on local climate. The lower night temperatures are raised inside the forest (blanketing effect) and the higher day temperatures are lowered (sheltering effects). There is also seasonal variation in the magnitude of these effects. For example the maximum blanketing effect is of the order of five degrees during summer, less than a degree during rainy season and five degrees during winter. Similarly the maximum sheltering effect is in the order of 2.5 degrees in summer and rainy season and 3.5 degrees during winter. Thus the maximum moderating effect due to both blanketing and sheltering effects is during winter when the range of variation of temperature is also large. The general behaviour of variations in temperatures inside the forest follow the corresponding changes in open. However, interestingly, it has been reported that the maximum temperatures inside the forest during summer could occasionally be higher than that in open. This is possibly due to the leafless condition of sal forest during summer (March–April) which allows more insolation of solar radiation inside the forest and the trees themselves prevent the hot air inside the forest from mixing up with cooler air in the upper layers. The differences between the temperatures at various heights are slightly more pronounced inside the forest than in open.

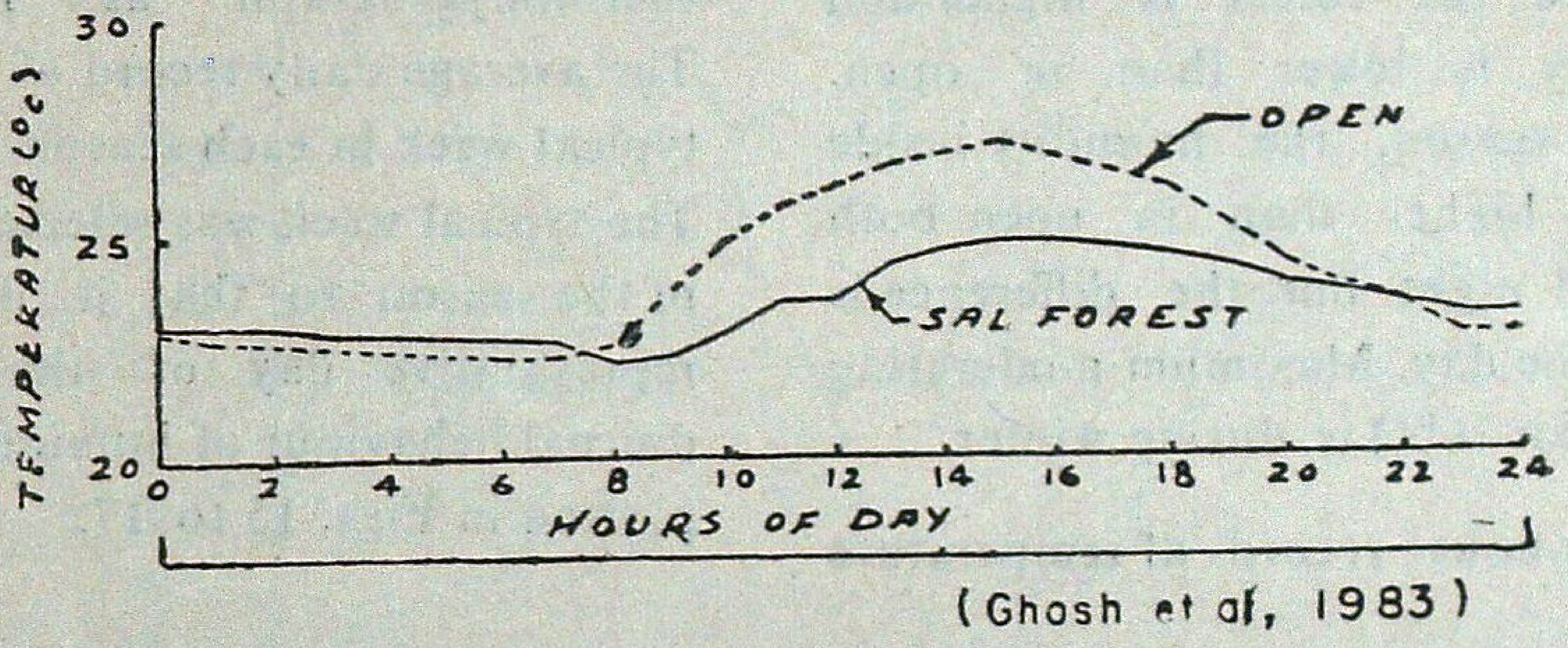
In Figure 12 the average hourly temperatures recorded by the thermohygrograph during mid–summer (for week No. 18) has been plotted. This gives a clear picture of the effect of forest cover on the air temperatures. During summer the forest cover exerts sheltering effect between 0800 hours to 1900 hours effect during remaining hours of the day. Maximum sheltering effect is 2.6 degrees and maximum blanketing effect 6.0 degrees. Also the range of variation of temperature is 22.6°C to 31.3°C (8.7 degrees) inside forest as compared to 18.1°C to 32.7°C (14.6 degrees) in open.

Similarly in Figure 13 the average hourly temperatures during mid-rainy season (for week No. 36) has been plotted, showing the sheltering effect exerted by forest cover between 0730 hours to 2100 hours and blanketing effect in the remaining hours of the day. Maximum blanketing effect is of the order of 2.3 degrees. Also the range of variation of temperture is 22.1°C to 24.9°C (2.8 degrees) inside forest as compared to 22.3°C to 26.9°C (4.6 degrees) in open.

The average hourly temperatures during mid-winter (for week No. 2) is plotted in Fig. 14. In this case forest cover exerts sheltering effect between 0945 hours to 1730 hours and blanketing effect in the remaining hours of the day. The maximum sheltering effect is of the order of 3.5 degrees and the maximum blanketing effect is 5.1 degrees. Also the range variation of temperature is 9.2°C to 16.0°C (6.8 degrees) inside the forest as compared to 4.8°C to 17.8°C (13.0 degrees) in open.

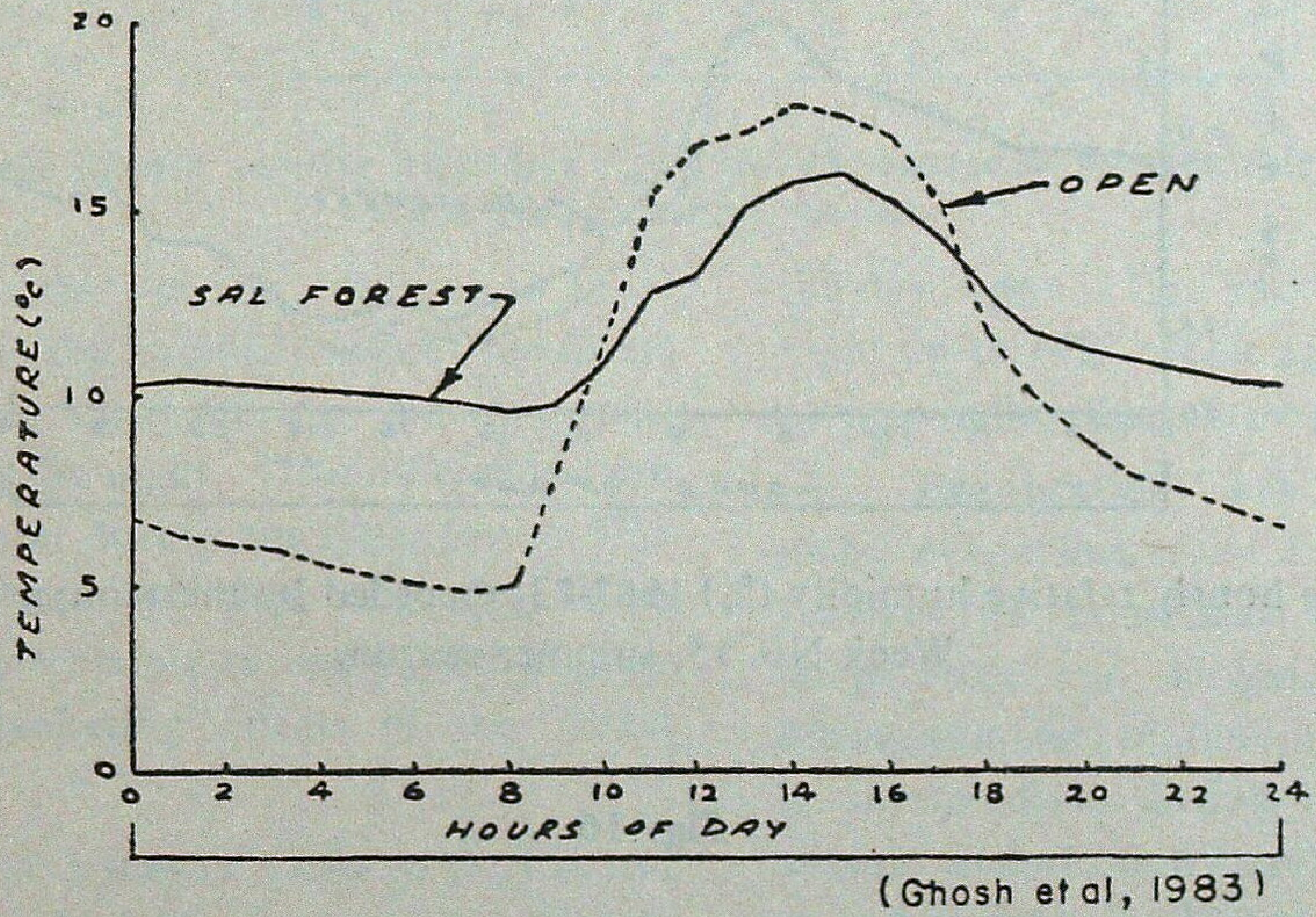
The influence of forest cover on relative humidity corresponds to the influence on air temperature. In summer, morning humidity inside the forest (av. 63%)

Fig. 13



Average hourly temperature (°C) 1967-73, recorded by thermohygrograph.
Week No. 36, rainy season.

Fig. 14



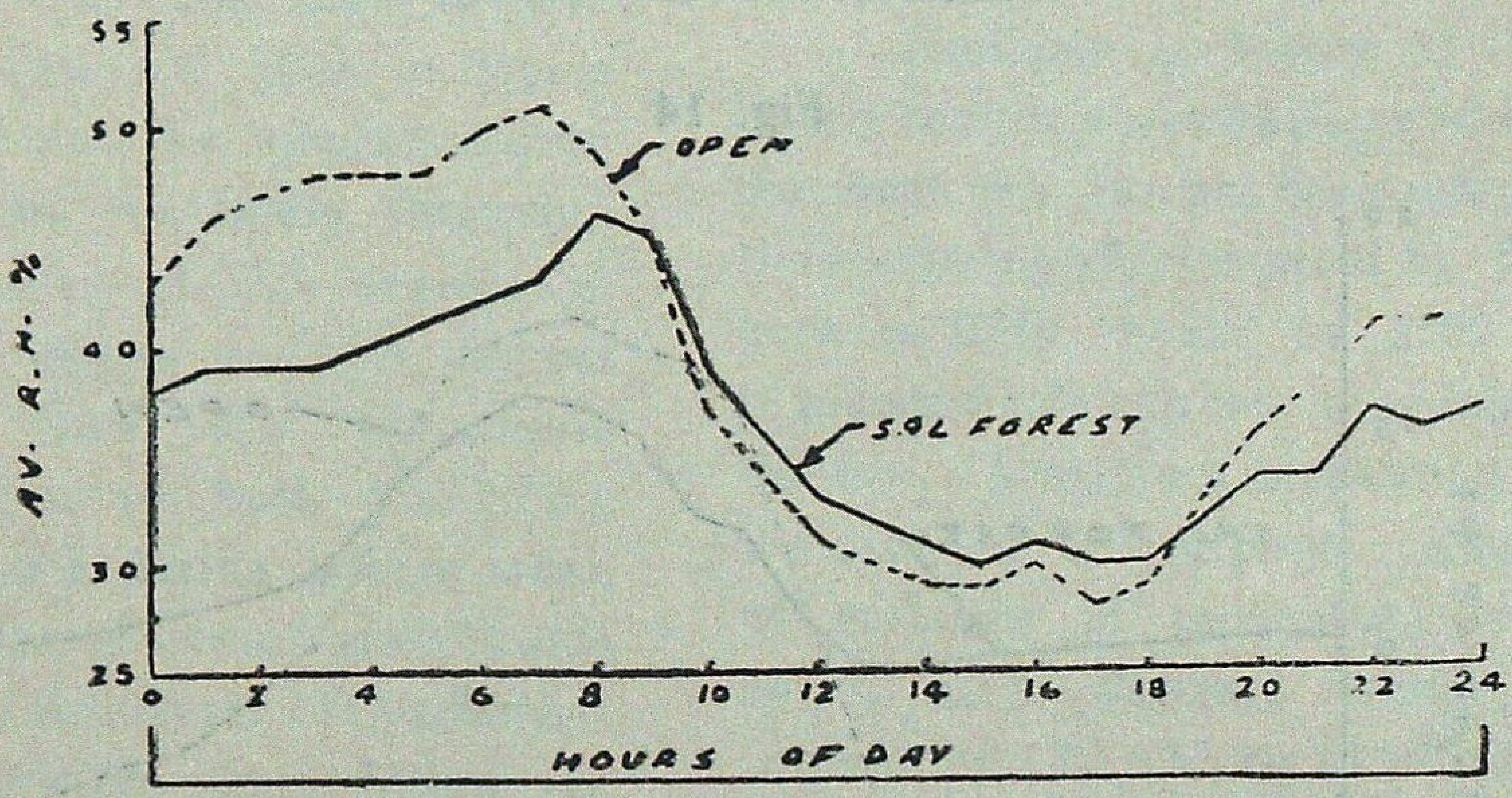
Average hourly temperature (°C) 1967-73, recorded by thermohygrograph.
Week No. 2, winter season.

is lower by 10% (due to warmer temperature-blanketing effect) than in open (av. 73%). In summer, afternoon humidity inside the forest (av. 36%) is always higher (by 2% to 9%, av. 3%) than in open (av. 36%) due to lower temperature-sheltering effect. During the rainy season, the morning humidity inside the forest (av. 90%) is lower by 3% than in open (av. 93%), and the afternoon humidity inside forest (av. 78%) is higher by 9% than in open (av. 69%). In winter, the morning humidity inside the forest (av. 74%) is lower than in open (av. 90%) due to warmer temperatures (blanketing effect) and the afternoon humidity inside the forest (av. 55%) is higher than in open (av 42%) due to the lower temperatures (sheltering effect).

During summer and winter, daytime humidity inside the forest is higher and night humidity is lower than in open. During rainy season, the humidity inside the forest is higher than in open both during day and night but the difference is larger during the day. Maximum moderating effect (more than 10%) is during winter.

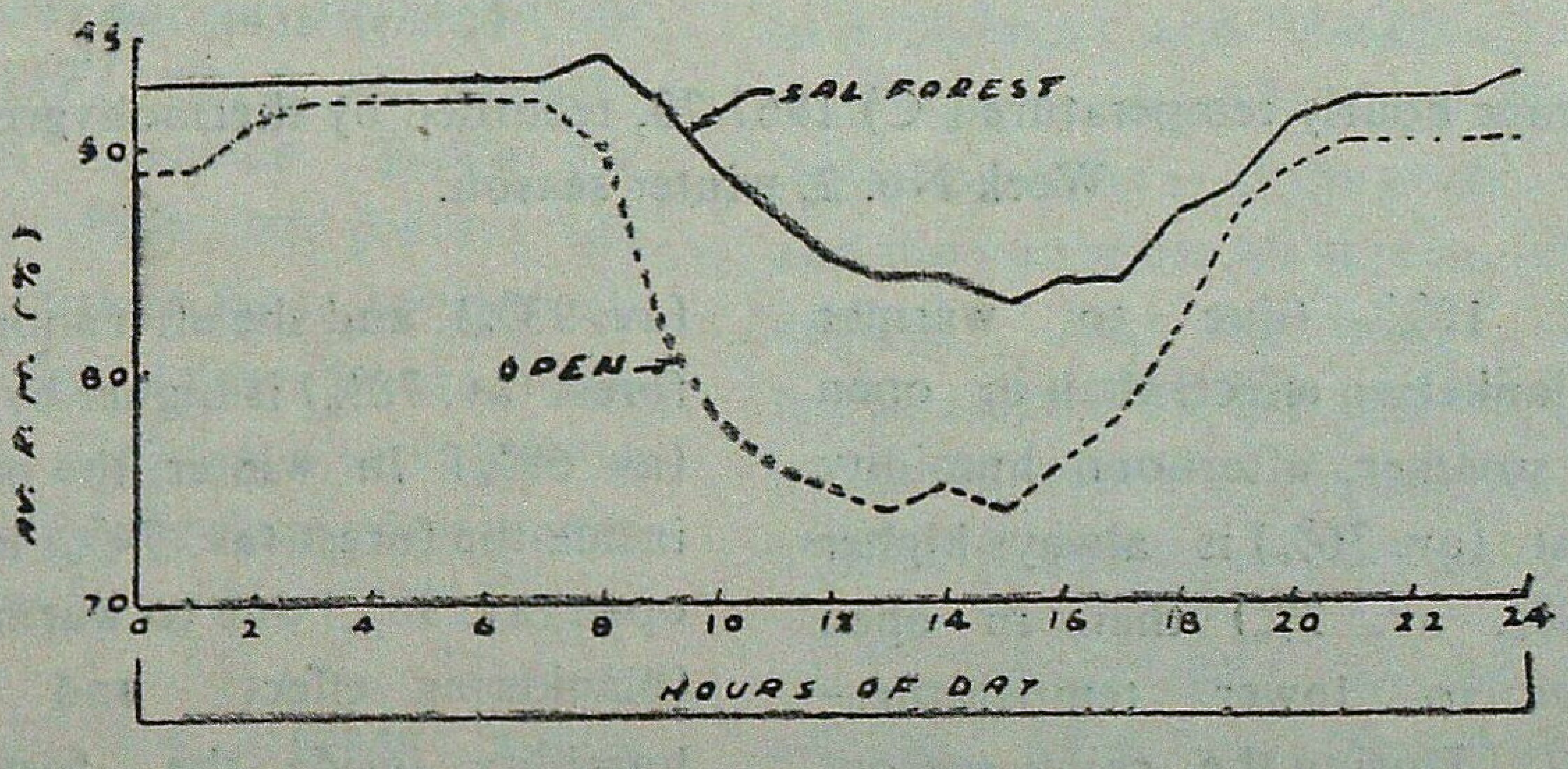
A continuous record of temperature and humidity was kept with the help of thermohygrograph at 122 cm height. The average daily record of humidity of one typical week in each season was worked out. The typical week was selected in the middle of the season so that it may serve as a represntative day of the season. The diurnal behaviour of humidity so derived is plotted in Figs. 15 to 17.

Fig. 15



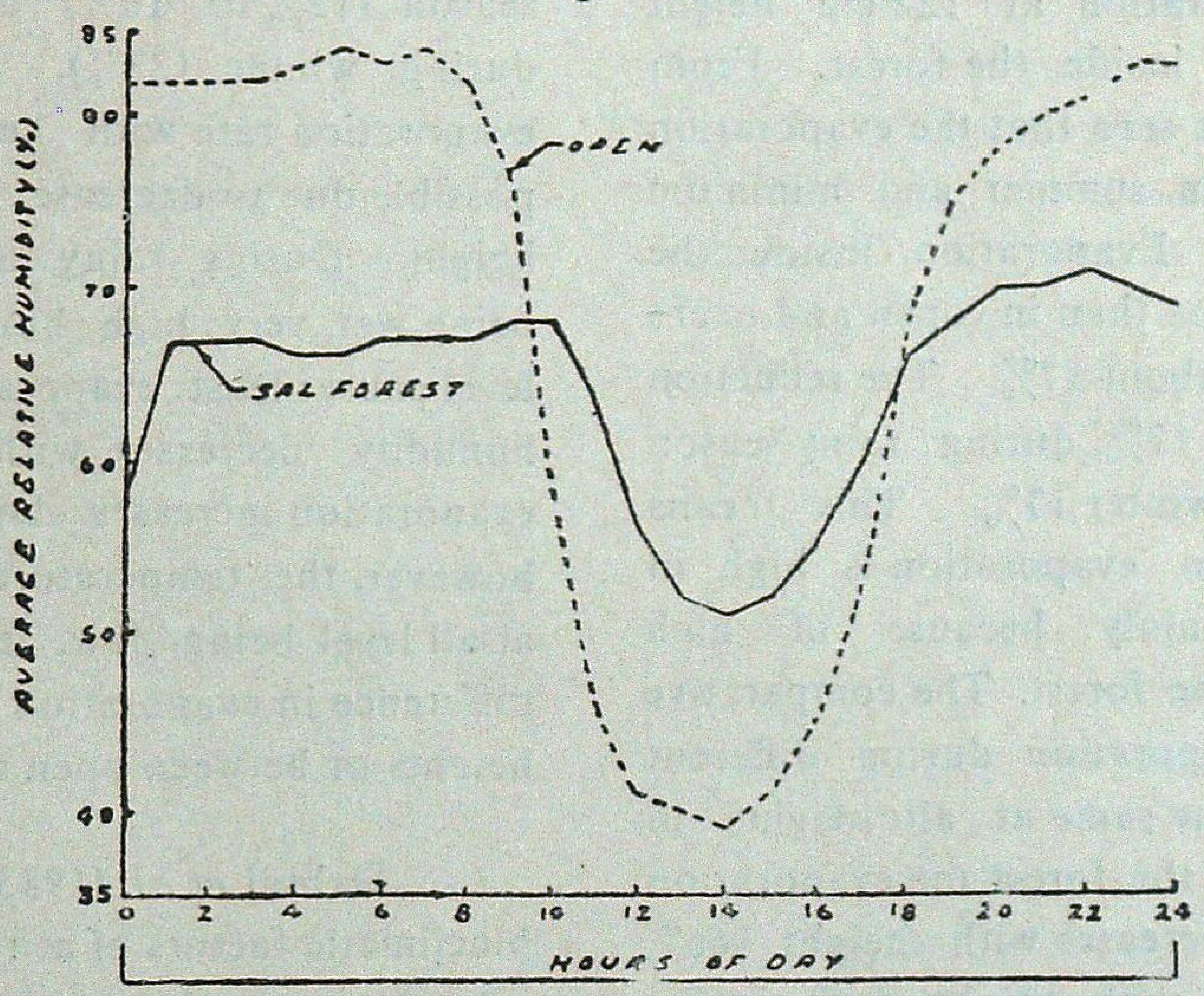
Average hourly relative humidity (%) 1967-73, recorded by thermohygrograph.
Week No. 15, summer season.

Fig. 16



Average relative humidity (%) 1967-73, recorded by thermohygrograph.
Week No. 36, rainy season.

Fig. 17



Average hourly relative humidity (%) 1967-73, recorded by thermohygrograph. Week No. 2, winter season.

In summer season (March to June) Fig. 15 shows the humidity inside the forest is higher than open during the day and lower during the night. The differences are however greater during the night (up to 8%) than during the day (less than 2%). These differences are mainly caused by the sheltering and blanketing effects of the forest cover.

For rainy season (July to Oct) as has been shown in Fig. 16 the humidity inside the forest is higher than in open throughout the rainy season. The maximum difference is during the day and is as much as 8% where as during the night difference is less than 4%. This fluctuation within a narrow range correspond to the small range of fluctuation in temperatures.

In winter season (Nov. to Feb.) maximum fluctuation in temperature and humidity is recorded, as shown in Fig. 17. Humidity inside the forest is higher during the day upto 12% and lower during the night up to 14%. This again is due to the corresponding fluctuations in temperature.

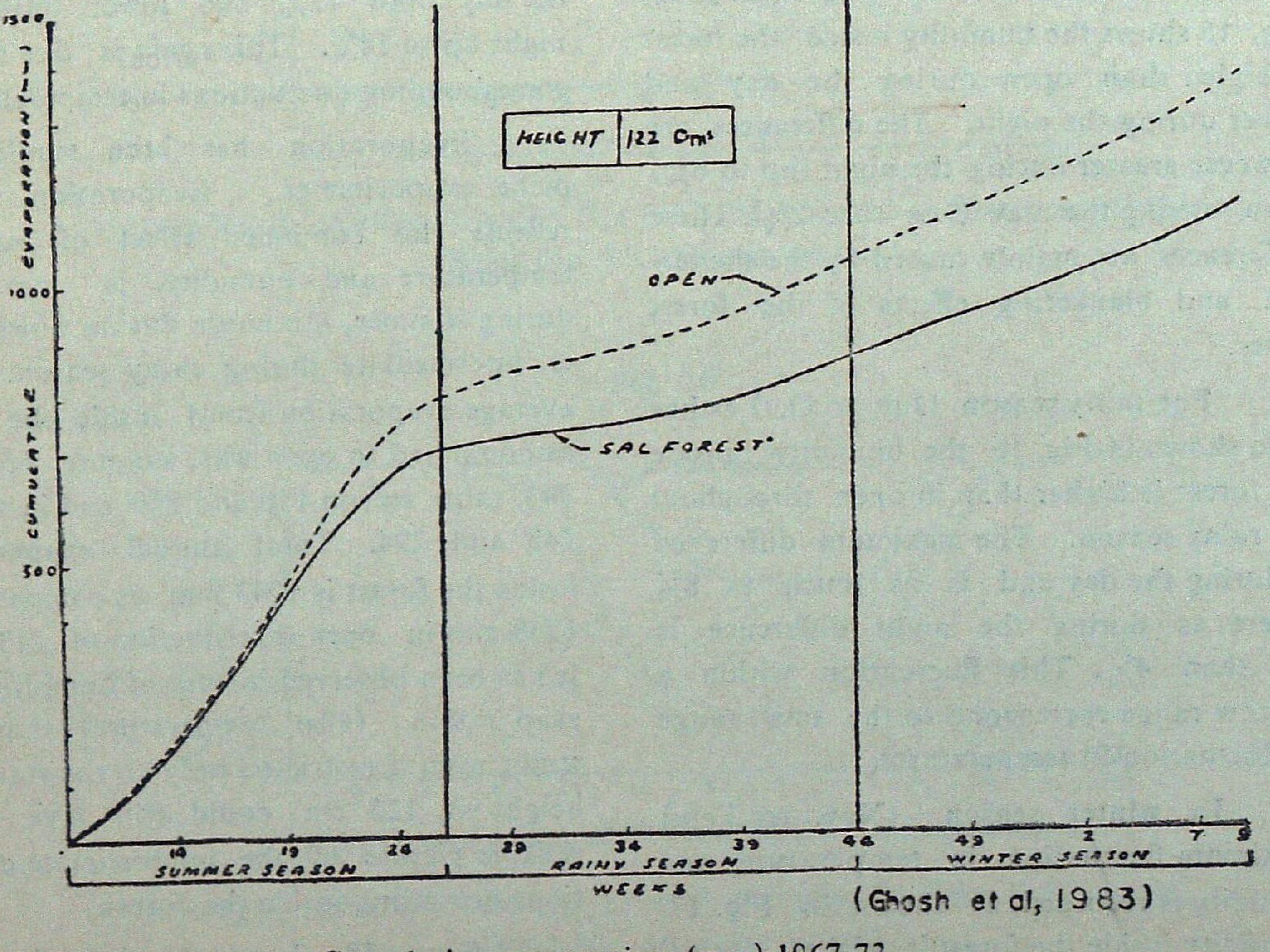
Evaporation has been studied by piche evaporimeter. Evaporation, which reflects the combined effect of *interalia* temperature and humidity, is maximum during summer, minimum during winter and is intermediate during rainy season. The average evaporation (mm) inside the forest as compared to open was, summer 652 and 743, rainy season 150 and 220 and in winter 243 and 294. Total annual evaporation inside the forest is 1043 mm as compared to 1258 mm in open–a reduction of 213 mm. It has been observed in case of humidity and evaporation (also temperature) that the study, even if restricted only to the standard height viz. 122 cm could still give fairly reliable picture of the microclimate conditions prevailing inside the forest.

Figure 18 shows the behaviour of

cumulative evaporation at 122 cm height both in open and inside the forest. From the figure it can be seen that the evaporation rate is maximum in summer and minimum in rainy season. Evaporation inside the forest is always less than in open and overall reduction is about 17%. The reduction during summer is 12%, during rainy season 32% and during winter 17%. This means that reduction in evaporation is high in rainy season mainly because of high humidity inside the forest. The comparative behaviour of evaporation during different seasons remains the same at all heights in open. But inside the forest the evaporation rate in summer decreases with height (65% to 60%) increases with height during rainy season (12% to 16%) and remains same during winter (23%). The decrease in evaporation rate with height in summer is possible due to decrease of temperature with height. During rainy season the ground being wet, very high humidity at the lowest level causes least evaporation also. As the humidity decreases with the height the evaporation increases. During winter season however, the temperatures and humidities at all level being low, there is not much difference in evaporation rate either between heights or between open and forest.

Dabral *et al.* (1983) have studied the bioclimatic factors of a regenerating natural sal (*Shorea robusta*) forest in Western

Fig. 18



Cumulative evaporation (mm) 1967-73.

Dehra Dun, under varying topographical and cover conditions. The age of forest stand is about 92 years. They have attempted to identify the factors responsible for the mortality of naturally regenerating sal seedlings. They have found that they are the cumulative effect of cold, heat or desiccation injury that ultimately results in mortality

Study by Samra *et al.* (1985) on the same subject is yet another attempt made to correlate some of the edaphic factors like toposequence, moisture retention-cum-aeration of soil, drainage and physico-chemical characteristics of lithosphere along with microclimatological factors of regenration of sal in West Dehra Dun Forest Division in Uttar Pradesh. Soil temperature and moisture at two depths along with air temperature at two heights were also monitored throughout the year. Due to absence of shrub layer and scanty ground flora low temperature and high amplitude of diurnal variation of air and soil temperature during winter season along with microtopographical conditions and other edaphic factors affected the natural regeneration.

Dabral (1985) has recently reviewed all the results of the microclimatic stud es conducted during the last twenty five years in the plantations of *Araucaria cunninghamii, Tectona grandis, Pinus roxburghii* and *Dendrocalamus strictus* and in natural forest of *Shorea robusta* (both coppice and virgin), at Dehra Dun. The relationship between the natural regeneration status and the prevalent environmental parameters lithospheric factors and soil moisture regime, has been discussed.

Further studies planned by the Forest Influences Branch of FRI are in the field of 'agro-forestry' which includes the micro-climate of man-made forest ecosystems and their effect on the agricultural crop production. The results of these studies are likely to become available in the next 5-6 years.

SUMMARY

The paper reviews the recent research advances in forest microclimatology in India. Most of the studies have been carried out in forest plantations at F.R.I., Dehra Dun and natural sal forests nearby. Salient results of the studies have been brought out.

भारत में वन अणु–जलवायु अनुसंधान में की गई विगत उन्नति

बी०के० सुब्बाराव व लक्ष्मी रावत

सारांश

इस अभिपत्र में भारत में वन–जलवायु विज्ञान में की गई विगत उन्नति की समीक्षा की गई है। अधिकांश अध्ययन वन अनुसंधान संस्थान, देहरादून म लगाए हुए रोपवनों तथा आस-पास के प्राकृतिक साल वनों में किए गए। इन अध्ययनों के मुख्य परिणाम भी सूचित किए गए हैं।

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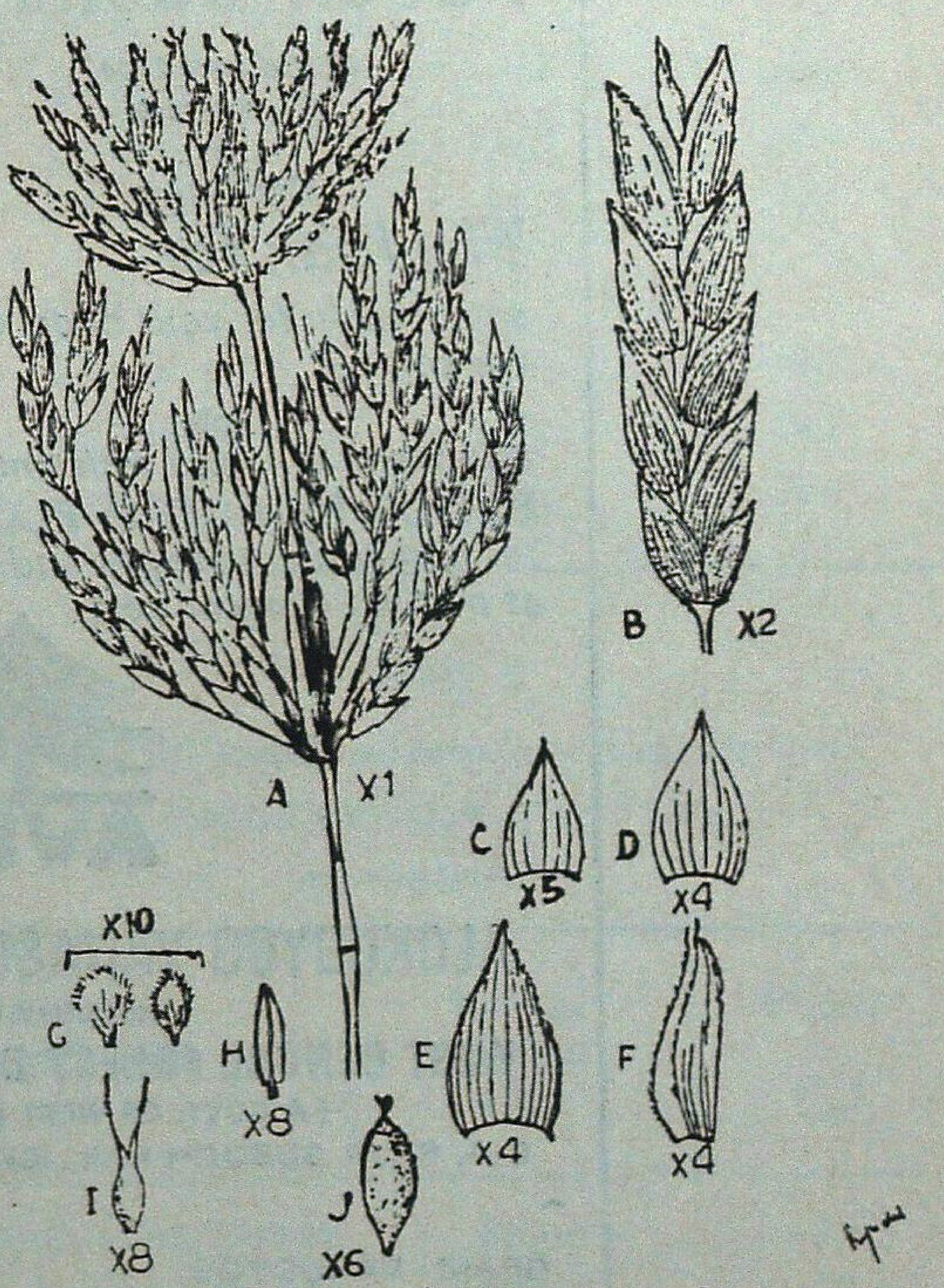
RESEARCH NOTES
(I)

A NOTE ON THE FLOWERING OF *CHIMONOBAMBUSA JAUNSARENSIS* (GAMBLE) BAHADUR & NAITHANI FROM INDIA

Chimonobambusa jaunsarensis (*Arundinaria jaunsarensis*) is distributed in N.W. & C. Himalaya from Jaunsar near Chakrata through Chamoli in Garhwal to the source of Pindar river in Kumaon between 1800-3000 m and is also cultivated in the U.K. and Ireland (Bahadur & Naithani, 1976). As this graceful species is rare, Bahadur & Naithani (1976) recommended its conservation. While dealing with this species in 1976 Bahadur & Naithani state— "It appears certain that this species flowered and seeded sometimes during 1861-1865 in India. The question whether it has ever flowered again after 1865 remains unanswered; the probability, however, being that it did flower but the event somehow passed unnoticed". According to Gamble (1921) this species flowered in England in 1910. Bahadur & Naithani received the flowering specimens of this species from England which was collected by Wilson in 1966. (151210 & 151212 DD).

While studying *C. jaunsarensis* collections of northern circle of Botanical Survey of India, Dehra Dun, a specimen of this species, in flowering stage, collected by Dr. A.S. Rao (No. 58423) on 3.7.1978, from Chamoli Distt., and identified as *Arundinaria falcata* Nees was found. Later on Mr. S. Singh, corrected the identity of this specimen as *Chimonobambusa jaunsarensis* (Gamble) Bahadur and Naithani (*A. jaunsarensis*). This appears to be the authentic record of flowering of this species in the recent past in India. As the description of the caryopsis is not available in the Indian literature, it is given here : Caryopsis; linear, *Ca* 4.0 mm long, trigonus, reddish, brown, with persistent styles.



Chimonobambusa - Jaunsarensis (Gamble) Bahadur & Naithani
A. Inflorescence B. Spikelet C&D. Empty Glumes
E. Lemma F. Palea G. Lodicules
H. Stamen I. Ovary J. Fruit

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(II)

A NOTE ON PARASITISM OF *ASPERGILLUS FLAVUS* ON *AILANTHUS* WEB WORM

During the course of study on entomogenous fungi, *Aspergillus flavus* Link ex Fr has been observed on dead larvae of *Ailanthus* web worm *Atteva fabriciella*. The fungus was quite pathogenic and caused mortality of larvae of *A fabriciella*. During the course of study of this insect pest, other fungi were also reported parasitising the forest pests (Dadwal *et al*, 1986).

In the present paper a comprehensive study has been made on pathogenic action of fungal suspension and culture filtrates of *Aspergillus flavus*. The fungal mat and culture filtrate of *Aspergillus flavus* were produced on liquid potato-dextrose agar medium. The fungal mat and culture filtrates were collected by filtering from 4 and 7 days old growth on the medium. The suspension of the fungal mat was prepared in distilled water whereas culture filtrate was diluted 50 : 50 with distilled water and sprayed on larvae with the help of an automyser. Thirty active larvae were taken in each treatments. The results are presented in Table 1 and 2.

The larvae of *Ailanthus* web worm become inactive within 24 hrs of fungal suspension. However intensity of larval death was in 4 to 5 days of treatment. The fungus made its way through head region and it appeared as white cottony growth.

Table 1

Effect of culture filtrate treatment on larvae and pupal formation after 5 days of treatment

Culture filtrate	Larval mortality (%)	Pupal (%)
7 days old :		
on leaves	100	Nil
on larvae	90	10
control	Nil	Nil
4 days old :		
on leaves	100	Nil
on larvae	100	Nil
control	Nil	Nil

Table 2

Effect of fungal suspension on larvae and pupal formation after 5 days of treatment

Fungal suspension	Larval mortality (%)	Pupal (%)
Applied on larvae	86.66	13.3
Applied on leaves	80	20
Control	Nil	36.6

The infected larvae exhibited fungal infection in the cuticle and also in the tracheal system which has been confirmed by transverse and longitudinal sections of the infected larvae. At the advanced stages of infection, the larvae became mummified and greenish brown fungal growth covered the larvae. At the time of mass rearing, the fungal growth developed on the pupae and such pupae could not develop into adult.

It is evident from the above table that the percentage of larval mortality was more with culture filtrate as compared to fungal suspension. In case of treated insects, pupal period was 5-6 days and longevity of adults 1-2 days whereas in control, pupal period was 5-6 days and longevity of adults 7-8 days.

The mortality of larvae is attributed to mycotoxins produced by the fungus *A. flavus* which is known to produce aflotoxins (Beard and Walton, 1971).

On the basis of laboratory studies the fungal suspension was also used for the control of *Ailanthus* web worm in nursery. It was observed that the results were not encouraging. This may be attributed to various factors like mobility of the target larvae, availability of untreated leaves and the preference of larvae for such untreated leaves. The field environment is not suitable for fungal development and suitable for larval growth and development.

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P.B. Meshram and V.S. Dadwal

(III)

PARTHENIUM HYSTEROPHORUS—A PERNICIOUS WEED IN ARUNACHAL PRADESH AND NAGALAND

During April 1984 in Arunachal Pradesh and in December 1986 in Manipur author has seen the population of a pernicious weed *Parthenium hysterophorus* between Detza and Tenga valley near Army Camps, West Kameng district (Arunachal Pradesh) and in Bus Station of Manipur State Transport Corporation, Dimapur (Nagaland). Voucher specimens were collected and deposited in the Herbarium of Forest Research Institute, Dehra Dun. One of the plausible explanation for existence of this weed in Arunachal Pradesh and Nagaland could be that the seeds might have come through the supply of food grains. On the rapid spread of *P. hysterophorus* in West Bengal the authorities are taking necessary action for its control.

Parthenium hysterophorus Linn. (Asteraceae) is a weed native of America where it is known as Santa Maria, Rag weed or White top. In India it is known as Kangres ghas or Gajar ghas and was introduced in 1810. This weed is now distributed over almost all the States of India, but from North Eastern India it has been reported only from Assam.

P. hysterophorus is pernicious weed and causes dermatites by contact or by pollen. In this unusual eczema the skin goes through various degree of swelling, oozing, damage due to uncontrollable scratching and ultimately becomes dark and thick like leather. The sites effected mostly are eye lies, neck, parts of face and back of knees. Even deaths have been reported due to exhaustion by itching from prolonged disease. Cattle which walk through *Parthenium* weed patches develop inflamed udder and subsequently suffer from fever and rashes. Dr. Ranade developed a vaccine for the effective treatment of this disease in 1976. It is reported to reduce the forage production by 90% in addition to making the land less fertile and also has become a problem weed for almost all crops. It produces enormous quantity of pollen, which shows allelopathic effect, which is likely to reduce crop yield up to about 40% even in the distant vicinity where *Parthenium* is growing.

Parthenium can be controlled by spraying 2, 4-D Sodium salt. Ansar 529 (MSMA). Bromacil, Diquat, Glycophasphate, Antrazine, Simazine, Chloroformuron, Monuron, Prametryne, Lasso and Diuron. Its biological control is the best long term solution. The species effective are *Aphis fabae*, *Pseudococcus* sp. Recently Syamasunder & Mahadevappa in *Curr. Sci.* 55 (5) 261-262. 1986 have suggested that *Cassia sericea* Sw., a native of tropical South

America particularly West Indies smothers the growth of *P. hysterophorus* and its introduction in India is more recent than that of *Parthenium*; a survey of many places in Dharwad and Belgaum revealed that the places where the *Parthenium* grew gregarously invaded by *Cassia sericea* and the growth of *Parthenium* has been considerabely smothered.

Since both in Arunachal Pradesh and Nagaland its occurrence is restricted to few places, therefore, Government and private bodies of these States are suggested to take an early action to eradicate this pernicious weed.

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H.B. Naithani

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GAZETTE NOTIFICATIONS

KARNATAKA GAZETTE

Shri S.K. Ramalingegowda, IFS, Deputy Conservator of Forests, Mysore Division, Mysore is appointed with immediate effect and until further orders as Deputy Conservator of Forests, Green Belt Division, Bangalore vice Shri S.G. Neginahal, IFS retired.

Shri C.S. Vedanth, IFS, Dy. Conservator of Forests repatriated from Government of India and awating posting orders is appointed with immediate effect and until further orders as Deputy Conservator of Forests, Mysore Division, Mysore vice Shri S.K. Ramalingegowda, IFS transferred.

Posting of Shri K. Sundar Naik, IFS, Deputy Conservator of Forests, Hassan Division, Hassan as Deputy Conservator of Forests, Green Belt Division, Bangalore ordered in Government Notification of even number dated 26-5-1987 is hereby cancelled.

WEST BENGAL GAZETTE

The Governor is pleased to appoint, until further orders, Shri P Guhathakurta, IFS, Managing Director, West Bengal Forest Development Corpn. Ltd. as Chief Conservator of Forests, West Bengal with effect from the date of his assuming charge vice Shri M P. Ray, IFS, to superannuate on 31.8.1987 (A.N.).

The Governor is pleased to appoint, until further orders, Shri G S. Mandal, IFS, General Manager, Alok Udyog Vanaspati Plywood Ltd., in the grade of Addl. Chief Conservator of Forests, West Bengal, with effect from the date Shri P. Guhathakurta, IFS takes over charge of the post of Chief Conservator of Forests, West Bengal.

The Governor is pleased to appoint, until further orders, Shri S Palit IFS, Conservator of Forests, Soil Conservation Circle as Conservator of Forests, Western Circle with effect from the date of his assuming charge vice Shri M K Chowdhury, IFS.

The Governor is pleased to appoint, until further orders, Shri J.N. Bhadury, IFS, State Wild Life Officer and Ex-officio Conservator of Forests as Conservator of Forests Soil Conservation Circle with effect from the date of his assuming charge vice Shri S. Palit IFS transferred.

The Governor is pleased to place the services of Shri V. Rishi, IFS at the disposal of the Environment Department of this Government for appointment on deputation as Director, Padmaja Naidu Himalayan Zoological Park, Darjeeling w e.f. the date of his release from this Department.

——-——

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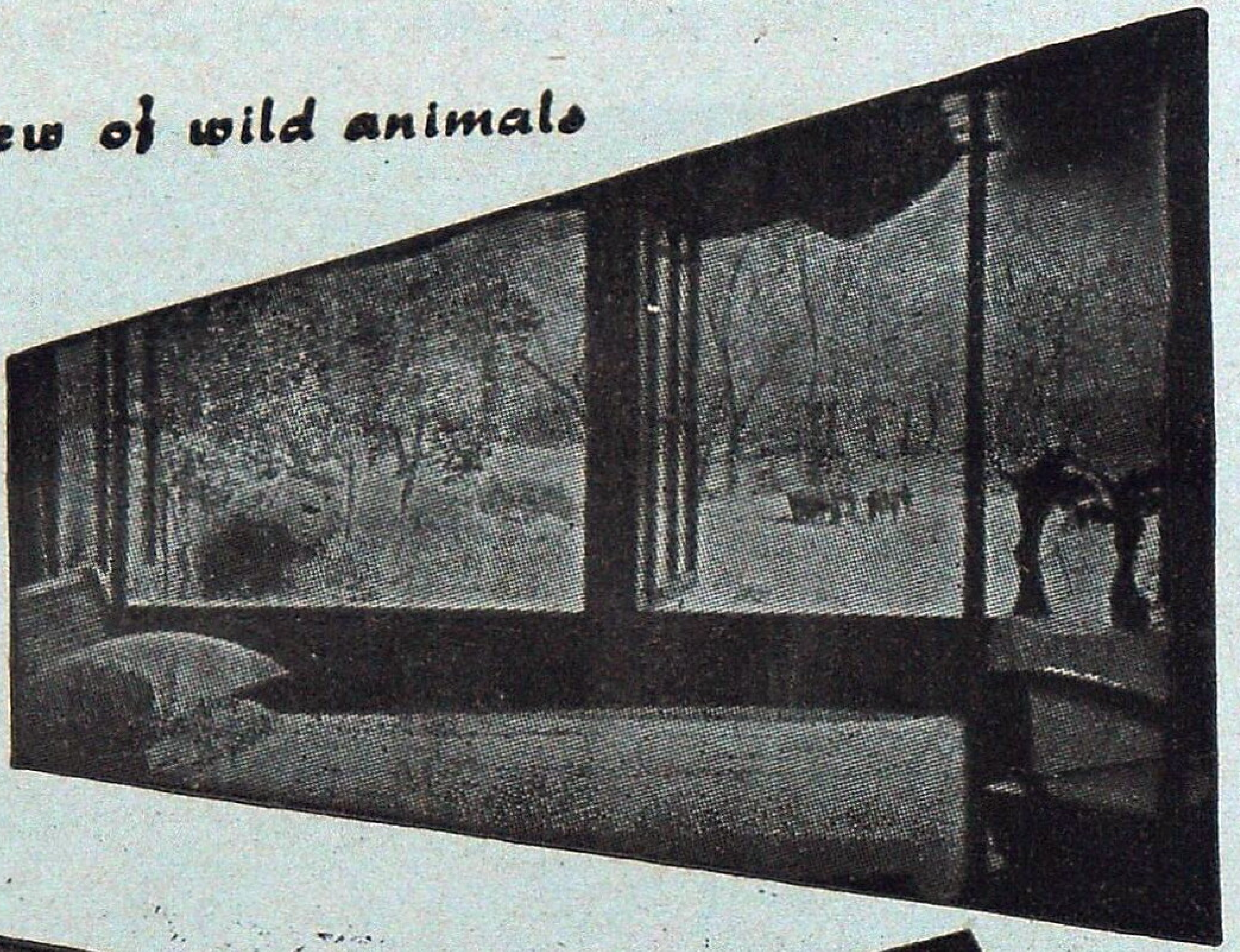

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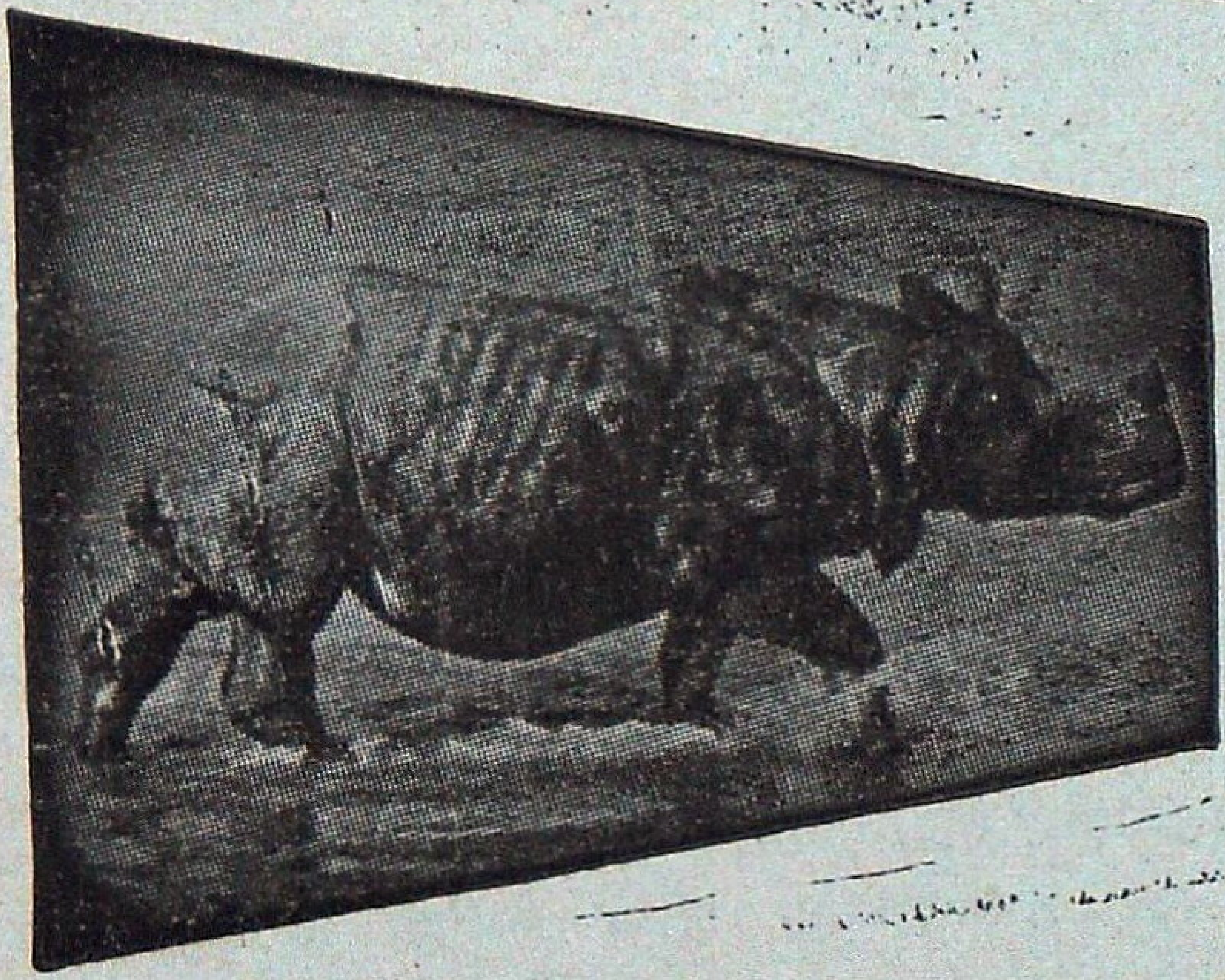

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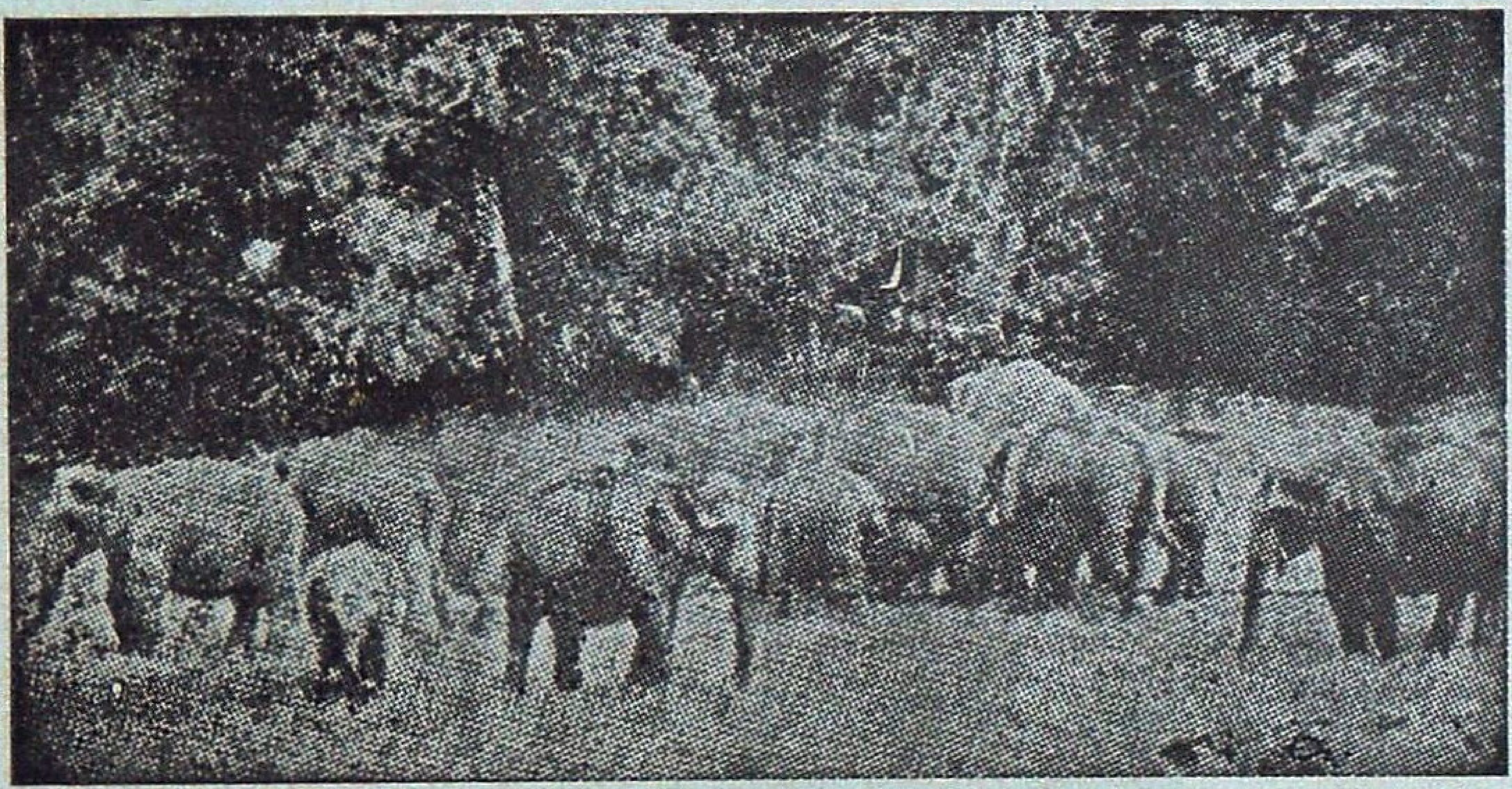

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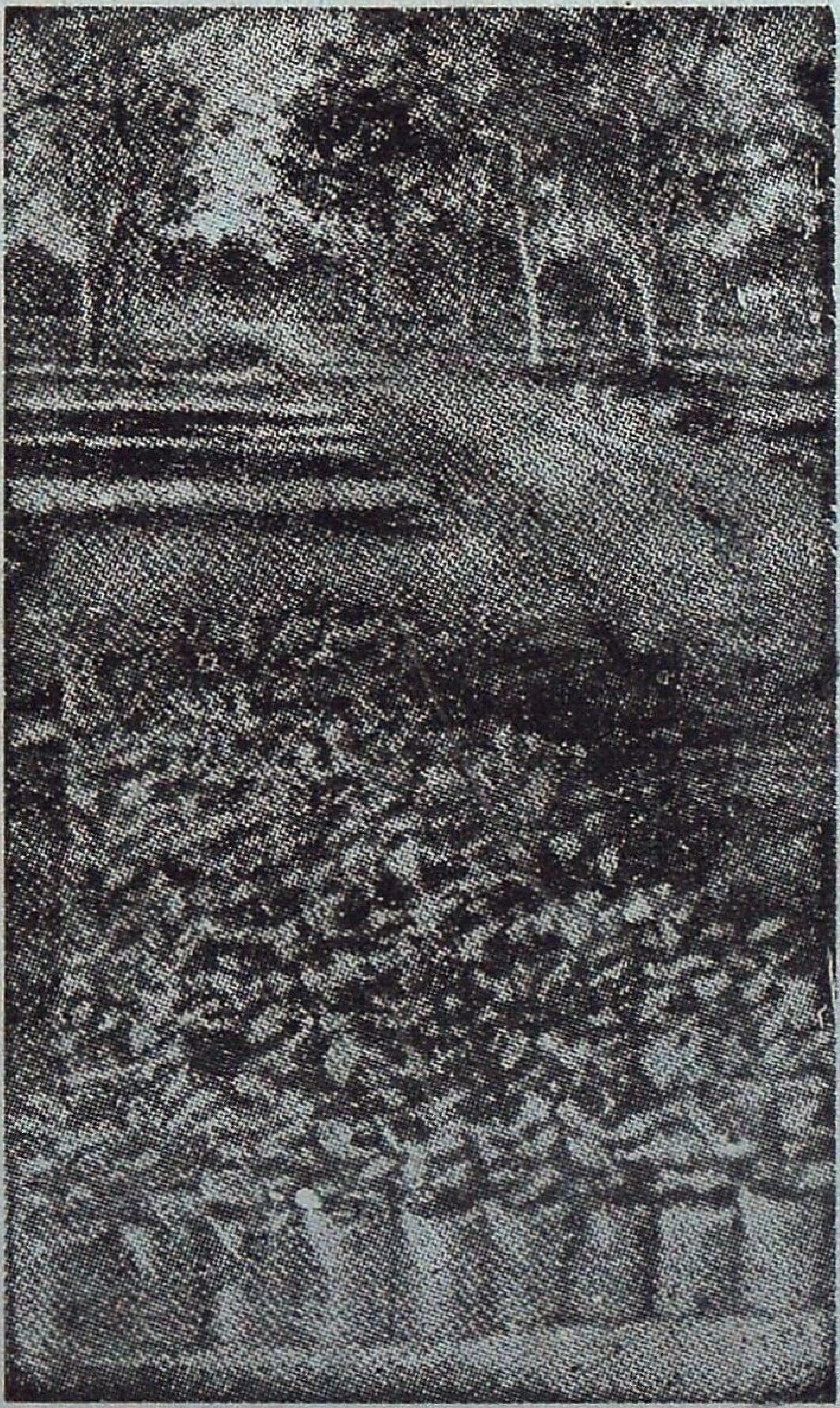

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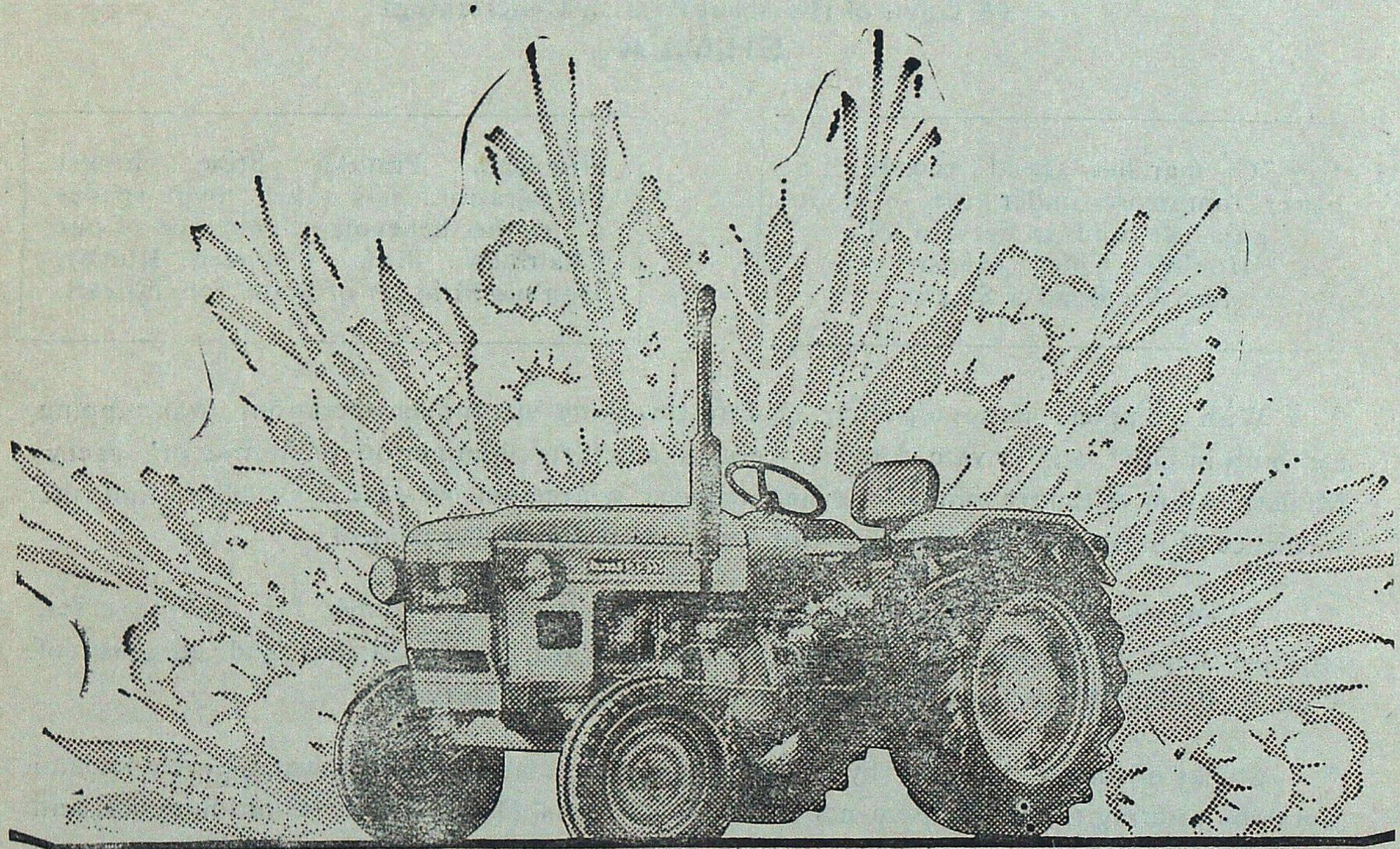

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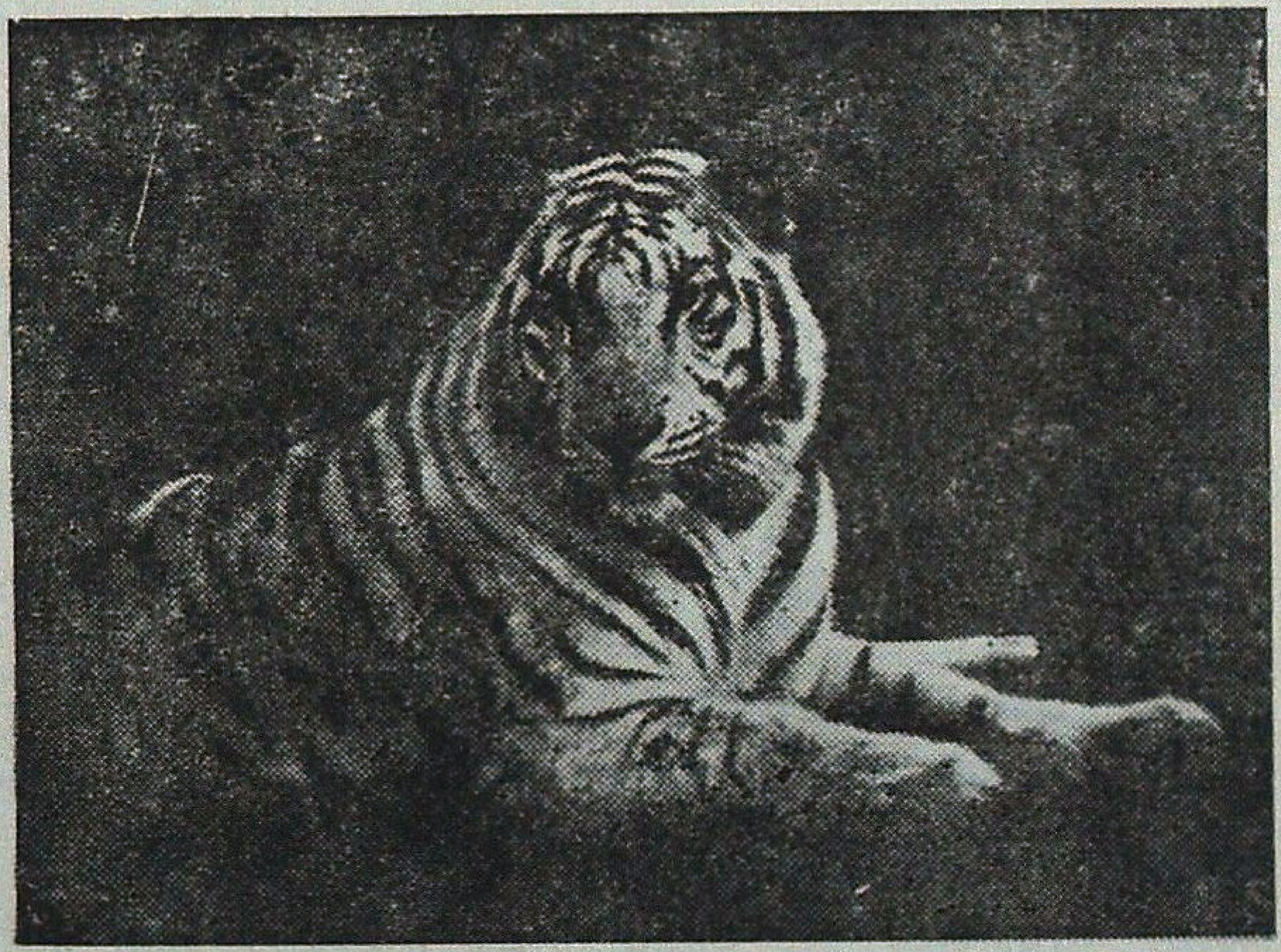

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For further details, please contact the Managing Director, Punjab State Forest Development Corporation Limited, Chandigarh.

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Versatile Eucalyptus

BY

B.K.C. RAJAN

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FOREWORD BY

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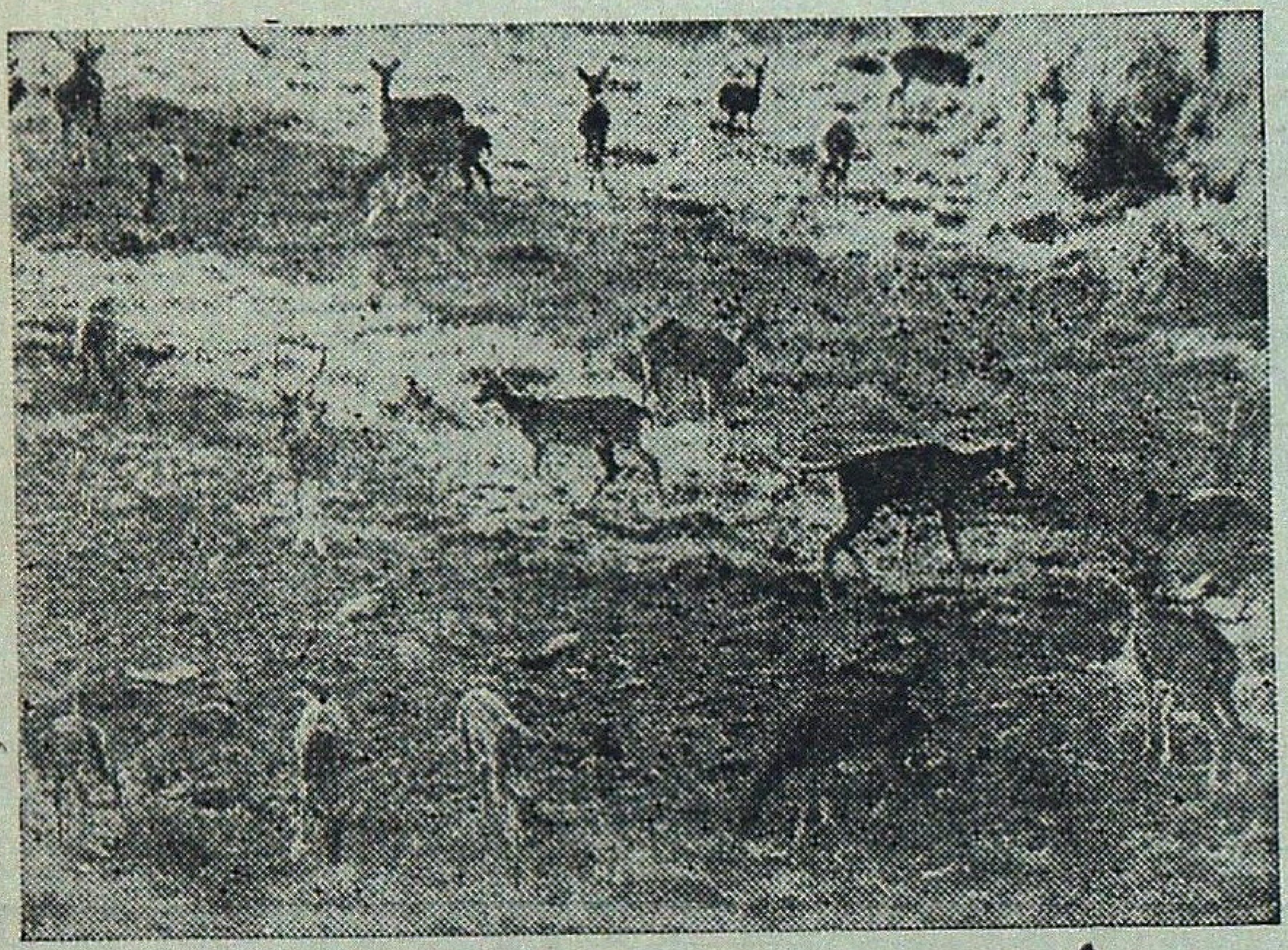

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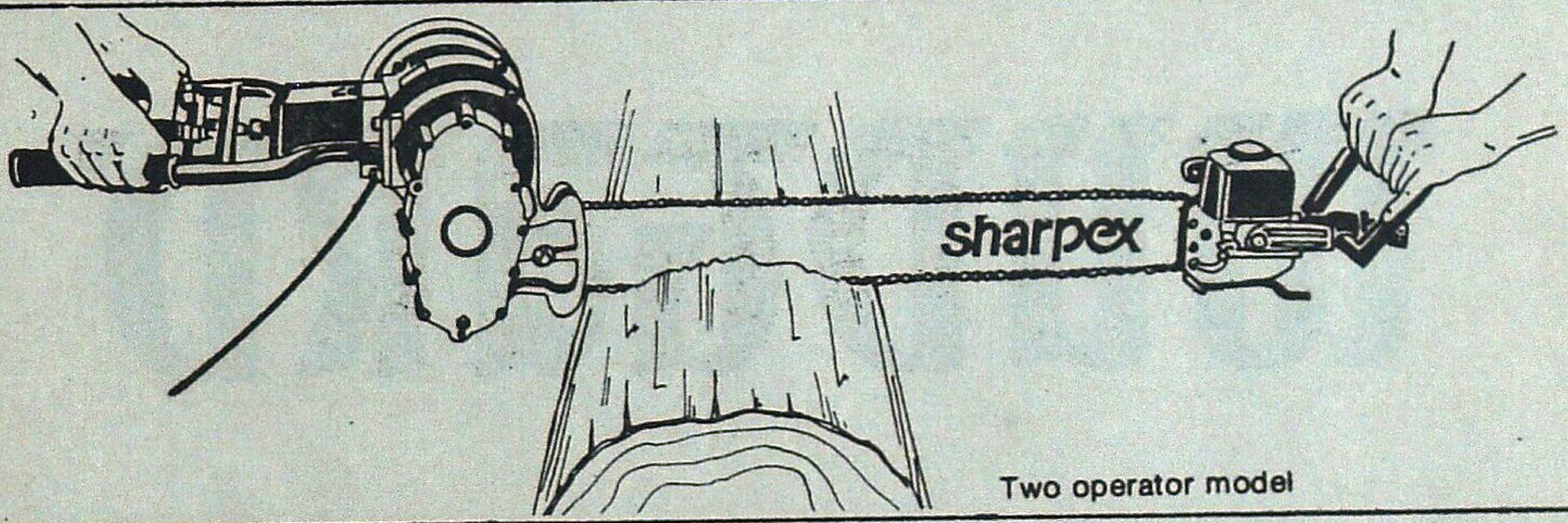

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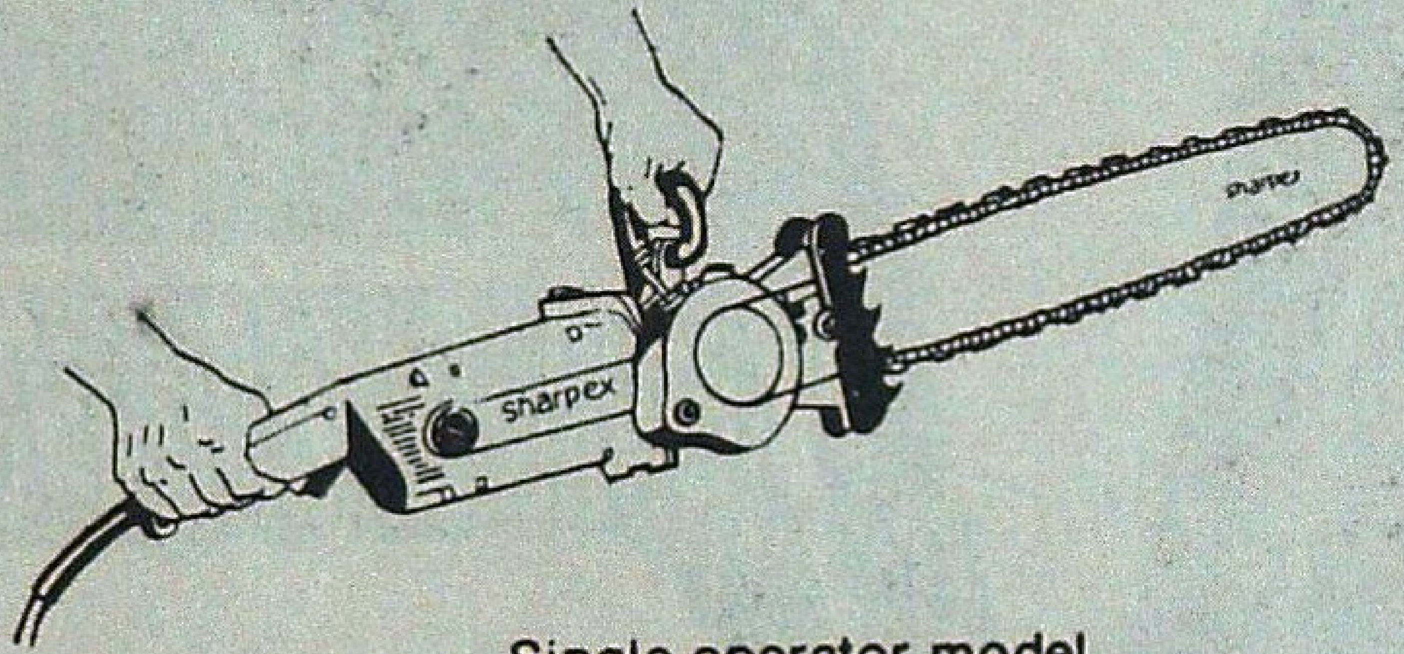

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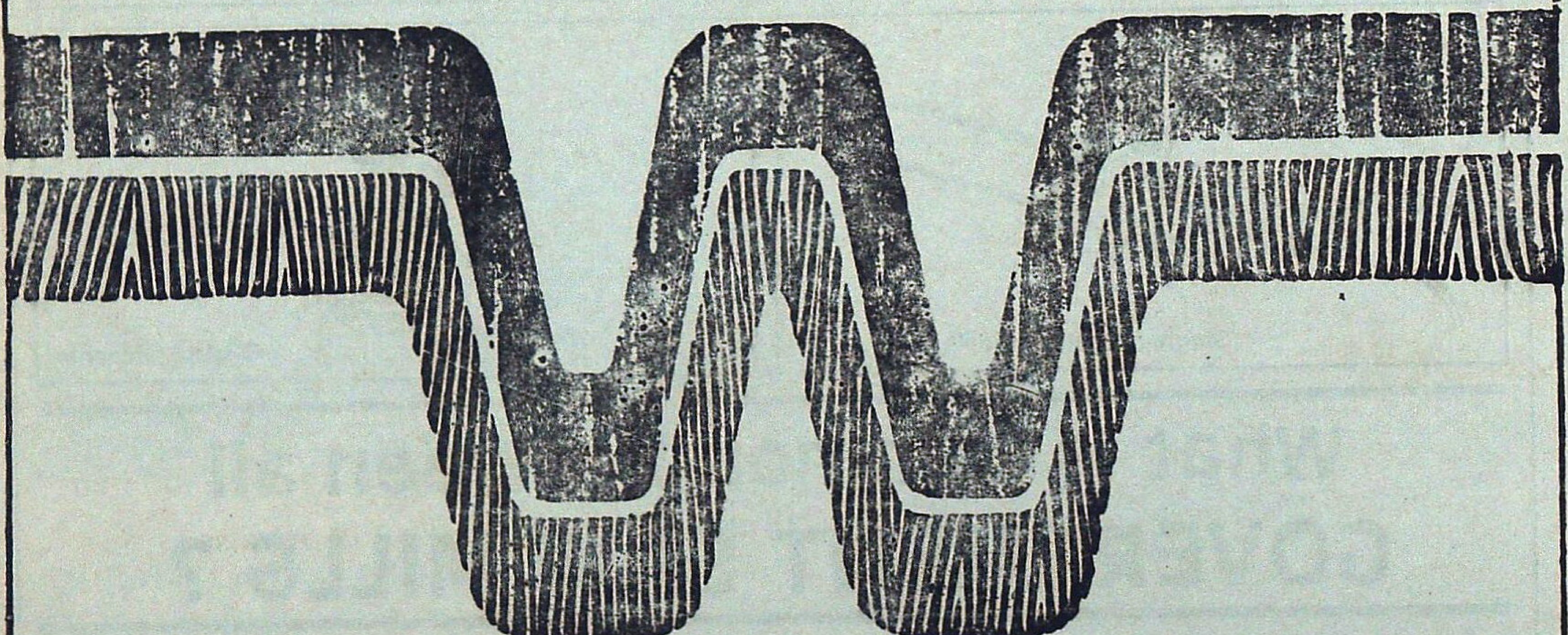

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NORVICSUM

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During the British period i.e. from 1890 till the year 1952, the management of Inner Line Reserved Forests was done under the supervision of Superintendent of District. The District was put under 'Excluded Area' and practically no Statutory Act or Law were enforced to manage the Forests. Practically nothing had been done. The Inner Line Reserved Forests was constituted under the Assam Forest Regulation comprising an area of 559 sq kms.

When the Mizo District Council came into being in 1952, the management of all the Forest other than the State Inner Line Reserved Forests was handled by the District Council. Thence the District Council started to make its own Forest Wing. Under the District Council one Forest Division called Aizawl Forest Division was created comprising the then whole area with headquarters at Aizawl In fact during the time of the then District Council, most accessible areas of the forests had been overtapped for earning more revenue and due to population pressures.

In the early 1960's the first plantations were raised by the District Council in different centres. During the year 1966 1968, practically no plantation could be raised due to political disturbance in the Mizo District.

After Mizoram became a Union Territory in the year 1972, the Union Territory Government formed one more Forest Division with headquarters at Lunglei

The present position of Mizoram Forest Department may be summed up as follows :

The Mizoram Forest Department is headed by the Chief Conservator of Forests. The field work has been taken up with ten (10) Territorial Divisions. In addition to this, six (6) Functional Divisions have been set up. There are now three (3) Circles namely—Southern Circle, Northern Circle and Research & Development Circle. The Government of Mizoram has already constituted three Wildlife Sanctuaries in order to preserve its vanishing Wildlife. Four more Wildlife Sanctuaries are being proposed which are likely to be constituted very soon. The Mizoram Forest Department has created 1,00,029 hectares of plantation upto 1987 as against 967 hactares before it attained U.T. Status.

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VOLUME 113 · OCTOBER, 1987 NUMBER 10

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